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THE

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THE ENGINEERING RESEARCH LABORATORY IN ITS RELATION TO THE PUBLIC.

A PLEA for more public recognition and support has recently been made by Prof. W. F. M. Goss, in a recent issue of the *Proceedings of the Indiana Academy of Science*, on behalf of laboratories which shall be devoted to research in the great subject of engineering. We find ourselves entirely in harmony with the Professor's views. He claims that laboratories of this kind are capable of the greatest public benefit, and that if we except religious and charitable institutions, there is nothing that can be so usefully supported as a research laboratory properly constituted and controlled. He points out very clearly the connection between the progress of engineering science and the welfare of the people at large. To restate an old truism, a "steam engine is one of the greatest pioneers of civilisation," and we have had a remarkable instance of this within the last few months, when, as Lord Kitchener himself would be the first to admit, the steam locomotive has enabled us to move down upon a barbaric and almost inaccessible foe, and restore to the regions of the Upper Nile the advantages of civilisation.

The basis of the whole science of engineering, extensive as it is, is to be found in facts which have either been deduced from practical experiments or derived from especially conducted experiments. The early engineer could neither lean upon accepted theories nor look to precedent for guidance. It was not what Brindley and Telford and Watt and the two Stephensons knew, but what they did, that helped to inaugurate our present era of engineering. Since their day, every important structure has served a double purpose: first, that for which it was especially designed; and, secondly, as a subject for observation and study. Where such structures have been a complete success, information concerning them has become a matter of record, and the essential facts have been given a place in the annals of good engineering practice; and where structures have failed, the causes have been carefully studied that the fault might be understood, and consequently avoided in future work. Success, therefore, has inspired imitators, and failures have warned all followers.

But while it is in this manner that a large part of our present fund of engineering data has been brought into existence, yet while the process still goes on, it is admitted to have its limitations. The attempt to make the same structure serve, for example, as a house and as a means of determining the behaviour of certain details entering into its construction, is illogical and expensive. Thus it is poor economy to ascertain the strength of an iron column by finally seeing it fall under the load of a wall. A crack in an arch, or a fragment from an exploded boiler may testify to faults in construction, and may even serve as a basis for theories leading to better practice; but the information obtained is dearly paid for in the damages suffered by the collapse of the arch, or the explosion of the boiler.

Again, great as are the losses occasioned by failures, they do not equal those which occur through fear of failure. The fear that workmanship may be bad, or materials defective, leads to lavishness, which would not be justified if our infor-

mation were more definite. It is indeed true that "factors of safety are factors of ignorance." When it is doubtful just how great a resistance can be withstood by a given bulk of material, we make success certain by building many times stronger than is really necessary. If we could know at the outset the exact value of the stresses involved, and the actual strength of the materials to be employed, it would become obvious that such a practice as this could give no additional security, and its results would be wastefulness.

In the domain of machine construction, the same general principle applies. The demand is everywhere made for machines that will act with a higher degree of efficiency; that is, do their work with less wear and tear, and at a lower running expense. There is no lasting market for inferior goods, and success in competition is to be obtained as the result of merit. Thus it is that designing engineers who give their thought and skill to planning great bridges, buildings, and machines, are successful, in proportion to their ability to simplify and cheapen, and at the same time perfect, while all unite upon the general principle that a bridge must not only stand, but it must also involve a minimum of material, and must do its work with the highest degree of efficiency.

It is clear, therefore, that what is needed in engineering work is a more perfect knowledge of the materials and forces involved. This is not a reflection upon the knowledge of the past, but a suggestion that its fund is insufficient for the future. The engineering of the last quarter of a century has done much to make definite matters which were before but little understood. Facts have been gathered and compared, and from them theories have been deduced. Failures are fewer, and the efficiency of structural work, and of machines of every sort, has been increased. But the end is not yet. To-day, more than ever before, the attention of the whole engineering world is directed to methods of improving and saving. Its efforts are put forth in response to the demands of a more exacting *clientèle*, and this *clientèle* is the public. It is evident that everything which contributes to the perfection of engineering methods must benefit the people, and must arouse their interest, for it is the people who finally reap the advantages, as well as pay the price. Hence public interest in the work of the engineer is keen and critical, and will always sustain any serious movement which promises to advance true practice. Such a movement presents itself in the establishment of laboratories devoted to engineering research.

When all forms of mechanical construction were crude, it was possible to improve by the mere application of experience, but as construction became more refined, it was necessary to examine with greater accuracy and to proceed with greater care. The crude stage in engineering is now a thing of the past, and every day increases the degree of refinement which characterises the work. The research laboratory stands as a response to these conditions. It is its function to investigate, in a scientific manner, problems which arise in practice or may be suggested by practical experience. The field of science and the field of engineering combined make up its proper domain. Its equipment, therefore, embraces the delicate apparatus of the scientist and the ponderous machinery of the engineer, and its lines of investigation may be chemical, metallurgical, structural, pneumatic, hydraulic or thermodynamic. Its methods eliminate the complicating conditions of service and allow effects to be traced singly to their causes. For example, efforts to determine the power and efficiency of locomotives while in service upon the road extend back through more than three decades, with no general result that is satisfactory. But the difficulties and inaccuracies which appear in the process of road-testing entirely disappear when tests are made in the laboratory, for here it is possible to maintain for an indefinite period an unvarying condition of speed and load, and to employ sensitive apparatus in observing the performance of the machine.

There have been many instances where locomotives on the road have left bent rails in the track behind them, but it required the laboratory to demonstrate that, under conditions not uncommon in practice, the driving wheels of a locomotive leave the track at every revolution. This having been proved, the matter of the bent rails was easily explained.

Again, it has been assumed for years that the draught produced by the exhaust steam in a locomotive was the result of an action similar to that of a pump; that each puff from the cylinder supplied a "ball" of steam which filled the stack as a pump-piston fills its barrel, and pushed before it a certain volume of the smoke-box gases until it passed out at the top of the stack. Believing this view to be the true one, designers have shaped the details of locomotive draught appliances accordingly, and the value of proposed improvements have been measured by the completeness with which they have satisfied the conditions of the accepted theory. But the processes of the laboratory have disproved this whole assumption. They have shown that the steam does not fill the stack except at its very top, and that the action of the jet is clearly one of induction. In accordance with these results, a new theory has been formulated, and although it is but a few months old, the laboratory facts which sustain it are so conclusive that it has already been generally accepted. These illustrations, drawn from a single field of investigation, will serve to show something of the character of the work done by the research laboratory. They might, with equal justice, have been selected from any one of the many different departments into which engineering research may be divided. But they have served their purpose if they have emphasised the fact that the laboratory gives results which cannot be obtained in any other way, and that these results may be relied upon to guide and direct practice in engineering affairs.

It is generally admitted that painstaking investigations in German laboratories have so well guided German manufacturers, that Germany not only competes with England in many lines of manufactured goods, but in some has driven her from her own markets. With such facts in mind, the conclusion is obvious that there is room and need in this country for more research laboratories. All such laboratories are but means to an end. They are not only contributors to the public fund of information, but they infuse into every branch of construction and of operation a spirit of accuracy and a desire for excellence.

We have noticed with satisfaction the growing tendency to encourage research in engineering which has found practical outcome in the establishment of well-appointed laboratories in connection with the great teaching centres of this country. In not a few instances these laboratories have been handsomely endowed by men who have had the intuition to observe that by apportioning their money in this way they were helping forward the future of their country. But much more, indeed, very much more, remains to be done. In spite of things accomplished, we are a long way behind such a country as Germany, where every branch of engineering is carefully fostered by the State. This beneficent form of socialism does not, perhaps, appeal to our English temperament and political attitude. But we must not rely too much upon occasional individual effort and assistance, or upon the help which rich City companies or endowment funds can afford. We must go further than we have ever gone before, and endeavour to enlist the interest of those who hold the great wealth that exists in this country—wealth which has in so many instances been acquired owing to the advantages which have been afforded by the achievements of the engineer. It is, perhaps, hardly for us to make a suggestion, for we only represent one branch of that mighty science which has made England great, but we humbly suggest that the Royal Society might very suitably take this matter up. True, it is more especially concerned with the encouragement of pure research, and it might be claimed that it was stepping out of its way in making this new departure. It is, however, for more facilities for pure research in engineering that we especially crave, and this great Society would be doing nothing derogatory to its position in fathering a movement for the establishment and endowment of research laboratories in the great centres of engineering. The ultimate aim of all effort is the benefit of mankind, and we agree with Prof. Goss that no branch of knowledge can show such magnificent results in this direction as the science of engineering.

A HOT-WIRE COMBINED AMPERE-VOLT-WATTMETER.

By MICHAEL B. FIELD.

THE principle which has been selected almost universally as the most suitable to base the design of wattmeters upon, is the mutual magnetic action of a shunt and series coil.

A method for power determinations occurred to the writer some time ago which might be termed a "two-voltmeter method," the watts being given by the difference of the squares of two-voltmeter readings.

With suitable connections it becomes possible to reduce the potential difference at the terminals of each voltmeter to a very low figure so that the lost power in the whole arrangement may be reduced to a mere trifling quantity without impairing the accuracy of the method.

This also permits of the employment of very low reading voltmeters constructed on the hot-wire principle, from which all disturbing effects such as are often produced by hysteresis, foucault currents, self-induction or capacity, and neighbouring conductors carrying heavy currents, are manifestly absent.

The object of the present article is to describe a hot-wire instrument devised by the writer for use in testing rooms, laboratories, &c., as a handy and accurate appliance for determining the conditions obtaining in any circuit, viz., the current strength, voltage, power, and power factor.

In fig. 2 a small view of such an instrument is represented, it consists of two hot-wire voltmeters so arranged that their pointers move over a common scale. L is a small lever at the side of the instrument, upon depressing which a piece of stiff paper is brought to bear upon the two pointers sufficiently to temporarily fix them in position while a reading of each is being taken.

At the same moment as the paper strip is brought to bear upon the pointers both hot wires become shunted, so that the mechanism which actuates the pointers through the medium of a special spring device, can return nearly to the zero position without overstrain and consequent damage. On releasing the lever, L, the hot wires are placed once more in circuit and the pointers take up their correct positions as controlled by the mechanism.

A further advantage of the hot-wire principle for instruments of this description is the possibility of making them absolutely dead beat. The ammeters and voltmeters of Messrs. Hartmann & Braun are quite remarkable for this quality. If, then, the arrangement as described above for holding the two pointers fixed while a careful reading is being taken be also attached, the probable error of observation is reduced to a very small quantity.

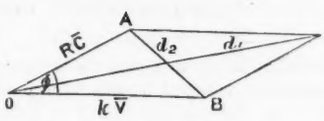


FIG. 1.

The main principle of the method is briefly explained as follows:—

Let v and c represent the instantaneous values of the current and E.M.F., and let k v and R c be voltages proportional to them obtained, for example, by means of a small transformer inserted across the mains, and a non-inductive resistance inserted in series in the main circuit respectively; let, further, D_1 and D_2 be the instantaneous values representing the sum and difference of the above voltages, *i.e.*,

$$D_1 = R\,C + k\,V$$
$$D_2 = R\,C - k\,V.$$

We have then the relation at every instant

$$\frac{D_1^2 - D_2^2}{4\,R\,k} = V\,C$$

(*i.e.*, the instantaneous value of the watts).

Representing by $\bar{D}_1$ $\bar{D}_2$ $\bar{V}$ $\bar{C}$ the effective values of the above quantities, and by Φ the power factor, we have as the effective value of the watts

$$\frac{\bar{D}_1^2 - \bar{D}_2^2}{4\,R\,k} = \bar{V}\,\bar{C}\,\Phi$$

and this is manifestly true for any shaped waves, lags, &c. We may represent $\bar{D}_1$ and $\bar{D}_2$ graphically, as follows:—

Let the length of the lines, O A, O B, represent the magnitude of the quantities, R $\bar{C}$ and k $\bar{V}$ respectively, and let ϕ be such that cos. $\phi = \Phi$.

Completing the paralellogram and representing by d_1 and d_2 the diagonals, we have the following purely trigonometrical relations—

$$d_1^2 - d_2^2 = 4\,R\,k\,\bar{C}\,\bar{V}\,\Phi$$
$$d_1^2 + d_2^2 = 2\,R^2\,\bar{C}^2 + 2\,k^2\,V^2.$$

If, now, d_1 and d_2 in the above equations be replaced by $\bar{D}_1$ and $\bar{D}_2$ respectively, we obtain two physical relations which we have already seen to hold quite apart from the diagram, hence it follows that if the parallelogram be constructed as explained above, with the sides, O A, O B, representing the magnitudes of the quantities, R $\bar{C}$ and k $\bar{V}$, and with the angle, ϕ, equal to cos.$^{-1}$ Φ, the diagonals will represent the magnitudes of the quantities, $\bar{D}_1$ and $\bar{D}_2$.

We see, then, that if we know any three of the five quantities R $\bar{C}$, k $\bar{V}$, $\bar{D}_1$, $\bar{D}_2$, Φ, the remaining two quantities may be determined graphically as indicated above, not only when we are dealing with sine waves, but also for any other shaped wave whatever.

Now it is only necessary to determine, experimentally, the voltmeter values, $\bar{D}_1$ and $\bar{D}_2$, in order to obtain the value of the watts. The method of carrying out this arrangement is indicated in fig. 2: M, represents a motor or other circuit,

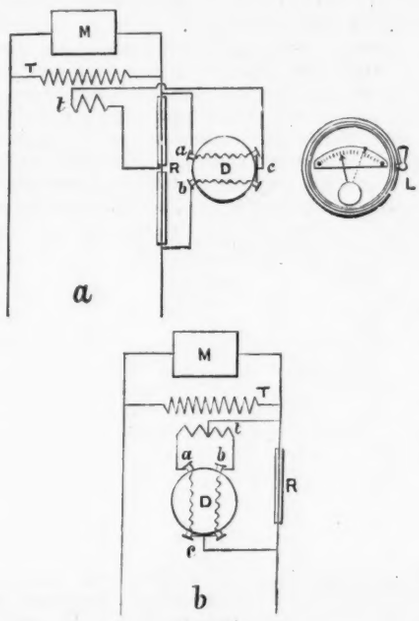


FIG. 2.

the power supplied to which is to be measured. In the main circuit a non-inductive resistance, R, is inserted, which will give a drop of about 1·5 volt with the maximum current. A transformer, T t, of which the secondary consists of but one or two turns, suitable for the generation of a voltage comparable with the drop across the non-inductive resistance, R, is connected across the mains as shown. There are many ways of connecting up whereby the same purpose may be effected, but here only two methods are shown:—(*a*) where the non-inductive resistance is divided, (*b*) where the secondary winding is divided. In the first case the drops across the two halves of the resistance, in the second, the voltage across the two halves of the secondary, are equal.

It will now be seen that the potential difference which exists between the extremities of the branches, *a c*, *b c*, cor-

D

responds to the vector sum and difference respectively of the E.M.Fs. which represent the main current and the supply E.M.F.

If, now, the two voltmeters, which together constitute the wattmeter, be inserted in these two branches, and be calibrated to indicate directly the mean square value of the potential difference at their terminals, the difference between the two indications will be a measure of the watts.

The instrument may further be combined with a change-over switch, which in the second position shall connect the hot wires, as shown in fig 3. In this position it will be seen

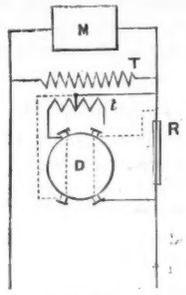


Fig. 3.

that the indication of the one needle is a measure of the current strength, while the second needle indicates the supply voltage.

Thus the same instrument, with the change-over switch in position (1) indicates simultaneously current strength and voltage, and in the second position true watts, from which results, of course, the lag of the current may be determined. The scales may either be graduated to show a given multiple of the mean square voltages, thus enabling the watts to be determined by simple subtraction, or otherwise, as is most convenient.

It is worthy of note that with the suspension adopted by the above-mentioned firm the scale is very nearly a square root scale, so that if graduated to indicate the square of the voltage an almost equi-proportional scale is obtained, which is without doubt the most convenient scale for an instrument of this type. A method employed with considerable success by the writer where only one instrument is needed, is shown in fig. 4, S is a reversing switch, a reading being taken in

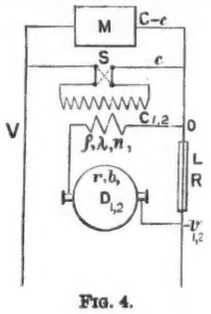


Fig. 4.

each of the two positions. The instrument used was a hot-wire voltmeter constructed by Messrs. Hartmann & Braun, having the series resistance removed. It could in this condition be used either as an ammeter up to 0·2 ampere, or as a voltmeter from 0 to 3·5 volts.

Before proceeding further, it will be well to examine this case analytically. As a matter of fact the excessively small self-induction possessed by the various branches are of absolutely no account, far less so than those in the ordinary two-coil wattmeter.

In order to make the case general, and to see in what way they enter into the result we will assume self-inductions in all the various branches, comparing the result with that of a two-coil wattmeter, thus clearly seeing the ground that justifies us in making the above assertion.

Let $\overline{v}$, v represent the effective and instantaneous values of the supply E.M.F. respectively.

Let $\overline{c}$, c be the effective and instantaneous values of the current passing through the non-inductive resistance (exclusive of c_1 or c_2 the secondary current of the transformer), c will thus consist of, c, the primary current supplied to the transformer, and $c - c$ the main current supplied to the motor.*

Let R and L represent the resistance and coefficient of self-induction of the so-called non-inductive resistance.

Let r and l represent the same with reference to the measuring instrument.

ρ, λ, n the resistance, coefficient of self-induction (or leakage coefficient) and number of turns of the secondary winding.

Let D_1 $\overline{D_1}$ D_2 $\overline{D_2}$ be the instantaneous and effective values of the voltage at the terminals of the measuring instrument in the two switch positions.

Take one terminal of the resistance R at zero potential, and the other at $-V_1$ $(-V_2)$.

Let F represent the magnetic flux in the core of the transformer and let θ represent the operator $\frac{d}{dt}$.

In order to avoid expressions of too great length we shall make the following abbreviations as we proceed, by writing:—

$$\begin{aligned} R' &\text{ for } R + r + \rho, \\ L' &\;,, \; L + l + \lambda, \\ I_m &\;,, \; \sqrt{R^2 + L^2 m^2 p^2}, \\ I'_m &\;,, \; \sqrt{R'^2 + L'^2 m^2 p^2}, \\ i_m &\;,, \; \sqrt{r^2 + l^2 m^2 p^2}, \\ p &= 2\pi \sim, \end{aligned}$$

$\sim$ representing the frequency of the supply current.

Considering fig. 4, we may express briefly the conditions obtaining in the various branches by the following equations:

$$\left.\begin{aligned} D_1 - (r + l\theta)\, C_1 &= 0 \\ (R + L\theta)\, C + (R + L\theta)\, C_1 - V_1 &= 0 \\ n\theta F - \{r + \rho + (l + \lambda)\theta\}\, C_1 - V_1 &= 0 \end{aligned}\right\}$$

Similarly, $D_2 - (r + l\theta)\, C_2 = 0$

&c., &c., replacing in the above D_1 C_1 V_1 (θF) by D_2 C_2 V_2 and $(-\theta F)$, and so on throughout.

Eliminating C_1 V_1 we have

$$\begin{vmatrix} D_1 & -(r + l\theta) & 0 \\ (R + L\theta)\, C & (R + L\theta) & 1 \\ n\theta F & -\{r + \rho + (l + \lambda)\theta\} & 1 \end{vmatrix} = 0$$

From which we obtain

$$\{R + r + \rho + (L + l + \lambda)\theta\}\, D_1 + (r + l\theta)(R + L\theta)\, C - (r + l\theta)\, n\theta F = 0.$$

Representing θF and C as periodic functions with respect to time (t) by the general expressions

$$\theta F = \Sigma F_m m p \sin (m p t + \epsilon_m).$$
$$C = \Sigma C_m \sin (m p t + \eta_m).$$

The summation being extended to all terms obtained by giving m successive integral values from 0 to ∞, we may write

$$(R' + L'\theta)\, D_1 = -\Sigma i_m I_m C_m \sin \left(m p t + \eta_m + \tan^{-1} \frac{L m p}{R} + \tan^{-1} \frac{l m p}{r}\right) + n \Sigma i_m F_m m p \sin \left(m p t + \epsilon_m + \tan^{-1} \frac{l m p}{r}\right)$$

whence $D_1 = -\Sigma \frac{i_m I_m}{I'_m} C_m \sin \left(m p t + \eta_m + \tan^{-1} \frac{L m p}{R} + \tan^{-1} \frac{l m p}{r} - \tan^{-1} \frac{L' m p}{R'}\right) + n \Sigma \frac{i_m}{I'_m} F_m m p \sin \left(m p t + \epsilon_m + \tan^{-1} \frac{l m p}{r} - \tan^{-1} \frac{L' m p}{R'}\right)$.

* N.B.—With the above arrangement where the two readings are taken successively, the value of C_1 varies slightly in the two switch positions, causing the primary current also to vary slightly. The error, however, produced by this variation of c is extremely minute, and in the other methods where simultaneous readings are taken, non-existent, so that it will be omitted altogether.

and $D_1^2 - D_2^2 = -4n \left\{ \Sigma \frac{i_m I_m}{I'_m} C_m \sin(m p t + \&c.,) \right\}$

$\left\{ \Sigma \frac{i_m}{I'_m} F_m m p \sin(m p t + \&c.) \right\}$,

and the value of $\frac{1}{T} \int (D_1^2 - D_2^2)\, d t$ integrated over a relatively long period of time T (which by our notation may be expressed as $\overline{D_1^2 - D_2^2}$), becomes

$$-2 R n \Sigma \frac{i_m^2}{I'^2_m} C_m F_m m p \left(\cos. \phi_m + \frac{L m p}{R} \sin \phi_m \right),$$

where ϕ_m replaces $(\epsilon_m - \eta_m)$.

Now, it is merely a matter of design to make the primary loss sufficiently insignificant, and we may write

$$-\frac{V}{N} \text{ for } \theta F, \text{ or } -\frac{V_m}{N} \text{ for } F_m m p,$$

N being the number of turns in the transformer primary, and we arrive at the final expression,

$$\overline{D_1^2} - \overline{D_2^2} = 2 R \frac{n}{N} \Sigma \left(\frac{i_m}{I'_m} \right)^2 V_m C_m \left(\cos. \phi_m + \frac{L m p}{R} \sin \phi_m \right)$$

This, then, is the general value of $\overline{D_1^2} - \overline{D_2^2}$, assuming self-induction and resistance in all the various branches and making no assumptions as to the shape of the current and E.M.F. waves, except that they are periodic with respect to time.

It will be interesting at this point to compare the above result with that of a two-coil wattmeter, assuming the latter to have self-induction in the shunt coil, and making the same assumption as above as to the current and E.M.F. wave forms. If r_1 and l_1 be the resistance and self-induction of the shunt circuit, we have for the force exerted on the movable coil,

$$f(P) \frac{r_1}{r_1^2 + l_1^2 m^2 p^2} V_m C_m \left(\cos. \phi_m + \frac{l_1 m p}{r_1} \sin \phi_m \right),$$

where f (P) involves a coefficient determined by the proportions of the wattmeter, and also depends on the relative position of the two coils.

It is highly interesting to note the following point of difference between the two wattmeters, viz, in the two-coil wattmeter self-induction in the main current coil is of no consequence, but in the shunt circuit it is very detrimental, while with the hot-wire instrument self-induction in the shunt branches produces little or no error, whereas in the main resistance it is of the greatest importance to eliminate it when large angles of lag exist. Next we see that self-induction in the resistance, R, enters into the expression for $\overline{D_1^2} - \overline{D_2^2}$ in almost exactly the same way as does the self-induction of the shunt coil of the ordinary wattmeter. Thus the higher the frequency (consequently the higher the harmonic) and the nearer ϕ_m approaches the value $\frac{\pi}{2}$ the greater is the relative effect of this self-induction.

Considering the case where the E.M.F. follows a sine law the error when $\phi = \frac{\pi}{2}$ will be, expressed in watts,

$$\frac{i^2 L}{I'^2} \frac{p}{R} \cdot \overline{V C},$$

and for all other values of ϕ the difference between the true and the observed values of the power will not exceed this amount.

It is, of course, essential to reduce the value of the expression $i^2 L / I'^2$ as much as possible in order to minimise this error.

Now, if in the two-coil wattmeter the self-induction of the shunt circuit, which contains a coil of many turns of very fine wire, and sometimes the secondary of a transformer which again represents a relatively large number of windings, can be made for all practical purposes insignificant, it is clear we are justified in putting L = 0, for, L being the self-induction of a short broad strip of some high resistance material forming the non-inductive resistance, the value of $\frac{L}{R}$ must be many times less than the corresponding value in a two-coil wattmeter.

(To be continued.)

THE BALL RACE.

By MARK BARR.

LET the *dilletante* over-praise a novel device, and the practical man will not make it. There is no direct logic in this, but the attitude is much justified by precedent.

In mechanics there are things which we need and things which we make. And among the things which have been needed badly since the wet Spring of '33, there are many not yet made. Now, the practical engineer is not, as Bret Harte would put it, a real mean man; he honestly desires to make the things we need. But he knows how easy it is to think and how hard it is to work.

For years the *dilletante* has very much enjoyed the thought of perfect steel balls; the *English Mechanic* has teemed with remarkably designed bearings, and friction seemed a thing of the past. But all this time it has been very hard to make the perfect spheres. Difficult as it was, however, there has been much fault on the part of the practical man. He will not repeatedly try to bring to perfection a thing against which he has been prejudiced by the theorist's enthusiasm in the first place.

Were it not for the evolution of the bicycle very accurate balls would be hard to obtain, and in the days when balls were bad many declarations were made in favour of the sleeve bearing and the collar thrust.

It is not yet generally known that balls are now made with truly marvellous accuracy; they may be now obtained correct to ·0001 inch, and in large quantities at that. One can now make use of balls in pivots and other bearings not only to reduce friction, but to obtain accuracy of setting. In a certain machine used by the Linotype Company for engraving minute type forms in hard metal, wherein, I may say, the very acme of mechanical nicety is required, ball slides and bearings are used with great success. The balls supplied for that machine can be lifted, a dozen at a time, between two perfect straight-edges, *edge on*, and held parallel in the same plane by ground blocks at the ends.

Some weeks ago a little discussion arose over the subject of ball races and their accuracy. I was designing at that time a special form of engraving pantagraph for linotype work, and as I had made use of ball-race bearings throughout I became much interested in the controversy. In the discussion referred to a geometric construction was shown which proved that, given perfect balls, true rolling friction could be attained.

Now, having in our possession balls which *are* spherical and which are so hard that the rolling friction in a hardened and ground race is next to nothing, we should see if the geometric construction given can be translated into simple dimensions for any special case. Very often the necessary dimensions for a trigonometric requirement are impossible to determine in the actual apparatus; we cannot draw construction lines, for example, within the body of our material.

Fig. 1 shows the diagram mentioned which gives the lower

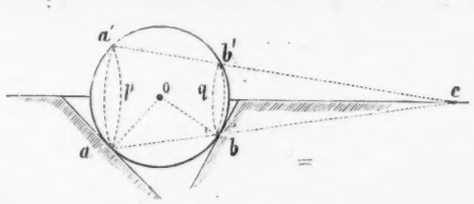


FIG. 1.

race and ball in sectional elevation. If c is the centre of the race, and o the centre of the ball, then the surface of the race must be tangential at a and b. The points, a and b, are obtained by drawing a line, $c\ b\ a$, as shown. This makes the rolling path, p, bear the proportion to the rolling path, q, which is necessary in bevel gears.

In order to give out a drawing for the workshop, we must calculate five of the seven dimensions marked in fig. 2.

We first choose the diameter of the ball, the number of balls and their clearance; then the diameter of the race, and finally, the minimum "depth of grip," which is shown as h.

Now, where R is radius of race, r radius of ball, d the clearance between balls, and n the number of balls,

$$R = \frac{2r + d}{2 \sin \left(\frac{180}{n}\right)^\circ}.$$

Choice can be made in the terms, but R should be suited to a practical clearance, a stock-size ball, and whole number for n.

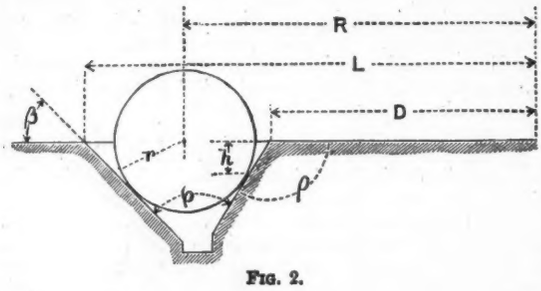


Fig. 2.

It is then necessary to find the formulæ for the race dimensions. These formulæ are very easy to obtain if it is assumed that the bevel angle, a, in fig. 1 is known, and this is generally used. But it is impossible to make use of this angle directly with jigs in the workshop. The bevel angle is determined by the "minimum depth of grip" wanted in relation to the clearance desired between the upper and lower races. Hence h should be chosen to suit these requirements. The plane through the centres of the balls is made midway between the flat surfaces of the two races, and thus h becomes a necessary dimension.

Taking h, R, and r then as known, I have worked out the following formulæ:—

$$D = R - \frac{r}{\cos\left(\frac{\phi}{2} - a\right)}$$

$$L = R + \frac{r}{\sin(\rho - \phi)},$$

$$\phi = 2 \sin^{-1}\left(\frac{R \sin a}{r}\right),$$

$$\rho = 90 - a + \frac{\phi}{2},$$

$$\beta = 90 - a - \frac{\phi}{2},$$

where a is the bevel angle found by

$$\sin a = \frac{h}{\sqrt{R^2 - 2R\sqrt{r^2 - h^2} + r^2}}.$$

Now, it is easier to use a right angle for the race than any other; therefore, in all cases where the thrust is not great enough to exert too powerful a splitting action, we can take ϕ equal to 90°.

In this case we have the much simpler formula:

$$D = R - \frac{r}{\sqrt{1 - \frac{h^2}{r^2}}},$$

$$L = R + \frac{r^2}{h},$$

$$\phi = 90^\circ,$$

$$\rho = 90^\circ + \sin^{-1}\frac{h}{r},$$

$$\beta = \sin^{-1}\frac{h}{r},$$

and there is no bother over the bevel angle.

Unless all dimensions are calculated trouble is sure to arise. Very small errors in graphic methods, even with large scales, make differences which are not always negligible.

Graphic methods on large scales are useful for highly complex calculations, but where one can obtain a simple formula it is better to avoid graphics if only to save time: once a formula is had one always has it. But an extra drawing board, paper, pins and time are required on each occasion of the graphic determination.

THE MANUFACTURE OF ALUMINIUM.

On the occasion of the meeting of the Institution of Mechanical Engineers at Belfast, in July, 1896, Mr. James Sutherland, the manager of the factory at Larne read a paper which fully described the method adopted for the preparation of pure alumina—oxide of aluminium—from bauxite. Members who then visited that factory will be interested to learn that the British Aluminium Company have already been compelled to enlarge the works to nearly double the capacity, and that great improvements have since been introduced into the process of manufacture. The finished product is a very finely divided powder, and in order to ship it safely to Foyers, it has been found advisable to pack the alumina in hermetically sealed steel drums. On arrival in Scotland the oxide is reduced by the Héroult process, and the metal is run out of the electrolytic baths into ingot moulds. In this form the aluminium is quite pure enough for certain purposes, such as foundry work and steel making, and much of it is therefore sold without further treatment. But as small quantities of the cryolite—a double fluoride of aluminium and sodium containing 13 per cent. of aluminium—which is used as a solvent during the electrolysis occasionally become mixed with the metal as it comes out of the furnace, the aluminium at this stage is scarcely suitable for the production of tubes, rods, &c. The original crude ingots are therefore sent to Milton, in Staffordshire, where they are re-melted and refined until the metal attains a purity of 99·6 per cent.

At the Birmingham meeting of the Institution of Mechanical Engineers, Mr. E. Ristori gave an exhaustive description of the Milton works, which showed very clearly the exceptional advantages which the British Aluminium Company possess there for converting the crude metal into marketable articles. For a description of the casting shop, the foundry, the rolling shop, testing machines, fitting shop and laboratories, we must refer our readers to the original paper.

With regard to the working of aluminium, which has hitherto been represented to possess so many difficulties, Mr. Ristori succeeds in showing that these have been to a very large extent surmounted. With certain limitations, imposed by the chemical and physical peculiarities of the material, aluminium can be worked much like the other industrial metals handled at the present day. It is best melted in sand or in iron crucibles without the addition of any flux, at a temperature not greatly exceeding its melting point, 655° C. = 1,210° F. On a larger scale, the operation can be carried out at a dark red heat on the bed of a reverberatory furnace lined with basic magnesia bricks of good quality. In casting, special precautions must be taken to allow for the great shrinkage during cooling. The moulds should have large risers and plenty of vents. They are preferably cooled from the bottom upwards to enable the gases to escape. Slabs for rolling must be cast in closed ingot moulds, with a perfect machined internal surface, which is coated all over with graphite and water; the moulds must be very hot, and the castings cooled quickly in very cold water to make them soft. Aluminium can be forged hot or cold; preferably at a temperature which causes a hard wooden stick to smoke when pressed against the metal. In comparison with other metals, it ranks third in order for malleability, and sixth for ductility; sheets have been hammered as thin as $\frac{1}{400000}$-inch, and wire can be drawn down to $\frac{1}{250}$-inch diameter. No lubricant should be used for rolling, and the aluminium requires frequent annealing at a low red heat, just visible in the dark. In turning, the edge of the tool soon becomes blunt, unless only small cuts are taken; the cutting speed should be high, and both tool and metal should be lubricated with turpentine or petroleum. Filing is best done with single cut files, because cross-cut files rapidly become choked. Spinning is easy on wooden or metal forms, the best lubricant being stearic acid dissolved in turpentine. Aluminium can be stamped or pressed, hot or cold, either dry or with soap water for heavy work, and with tallow for small goods. Frosting is effected by dipping the articles for a few seconds in a hot 10 per cent. solution of caustic soda containing about 2½ per cent. of common salt, till the surface turns black, then brushing with cold water, and dipping in strong nitric acid till the metal becomes white again, and finally

washing and drying in sawdust. This process is desirable before aluminium surfaces can be efficiently painted or enamelled. For polishing, a mixture of olive oil and rum is used, or emery and tallow, followed by rouge and turpentine. Burnishing is done with bloodstone or steel dipped in rum and oil, or in a solution of borax containing a little ammonia. To engrave aluminium, the plate must be coated with stearic acid and turpentine, or with rum and oil, as before; if this be not done, the graver slips continually.

It has been claimed by many that aluminium will find its chief utility in the direction of alloys, and we find that much attention has been paid to these. In its purest form aluminium is very soft, and of no great service in those arts in which much rigidity and strength are required. Actually, an impure aluminium, containing about 98 per cent. of aluminium, is preferred to a metal of greater purity. Many alloys, especially those which are termed "light," have been discovered, and two especially are now being used to a large extent. These are ternary alloys, and are called "Wolframinium" and "Romanium." Tungsten is the leading ingredient in each. There are also many "heavy" alloys of aluminium, in addition to the well-known bronzes, and some of these are very much used by the French Admiralty, especially for the manufacture of propellers.

The principal uses of aluminium are too many to be enumerated. The properties of the metals are so akin to those of copper and brass that, broadly speaking, aluminium, or one of its light alloys, should to a large extent replace both copper and tin, and also nickel or German silver. Such a change would be followed by various advantages to all concerned. Not only would there be a considerable reduction in the weight of the articles, but they would not tarnish or turn black on exposure to air. The cost should be the same, if not actually lower, inasmuch as, bulk for bulk, aluminium is already cheaper than copper or tin, and its price will continue to fall as the demand increases. One field, however, remains, which copper is bound to maintain as its own, namely, the construction of insulated electrical conductors. Experiments have already been made on a large scale with bare conductors of aluminium for telephones, &c., and the British Aluminium Company are using it in this manner at their Foyers works with perfectly satisfactory results, its conductivity, weight for weight, being double that of copper. But when the mains have to be insulated, copper is absolutely unapproachable, on account of its greater conductivity, volume for volume, which is 165 per cent. of that of aluminium. Besides the advantages set forth above, aluminium is not poisonous, and is pre-eminently adapted for the manufacture of cooking utensils. On the other hand, tinware is not particularly cheap in the long run, for it is constantly wearing out; cast-iron is heavy and brittle, and copper requires to be frequently re-tinned in order to avoid all danger to health. Inasmuch as an aluminium saucepan costs no more in the first instance than a copper one, weighs much less, is perfectly innocuous, and does not periodically need a fresh inside, it is not surprising that the employment of aluminium in kitchens and canteens is spreading rapidly. A steady demand for aluminium is springing up in various kinds of printing processes, as well as in lithography. The metal appears to answer admirably for the construction of rollers used in calico printing, and when its surface is properly prepared, it is also capable of replacing the ordinary lithographic stone. It can easily be imagined that, instead of having cumbrous and heavy stones, which can be printed only on special slow-running "litho" machines, it is far better and cheaper to use thin sheets of a metal which can be bent into a circular form and printed on rotary presses.

One of the largest uses to which aluminium has been applied is in metallurgy, where its valuable metallurgical properties were discovered and utilised. It is common knowledge amongst steel makers that ingots often turn out spongy at the top, and when particularly good ingots are required the faulty portion is cut off and melted over again. By the introduction of a very small proportion of aluminium to iron, steel, or brass, either in the mould or in the ladle, the founder can be quite certain that the ingots will be solid all through. When used in this way, aluminium has the peculiar virtue of instantly liberating all the gases contained in the metal, and of keeping it fluid for a longer period, so that by the time the casting solidifies the gases have had an opportunity to escape. In almost all steel works, and in all the principal foundries, aluminium is now being employed; and reports from some of these state that the result is a reduction in the wasters of 80 or 90 per cent. In this case aluminium does not actually replace any other metal, but by its own special qualities is useful as a means of improving physically and chemically some of its older rivals and friends.

The use of aluminium in ship building is growing rapidly on account of the almost unestimable advantage of its great saving in weight. It is only four or five years ago that a small canoe was made on the Thames, out of two sheets of aluminium, stamped and riveted together; but now torpedo boats, yachts, launches, and other vessels are being made. Scarcely any industry that can be instanced can show such a rapid advance as this. Indeed, aluminium is quite *fin de siècle*, and he would be a bold prophet who would venture to define its position in the economy of civilisation 25 years hence.

THE LONG-SCHATTNER PREPAYMENT METER.

Electrical meters depending on the measurement of the electrolytic action effected by the current to be metered have been proposed by several recent inventors, and the records of the Patent Office of the last 20 years contain, we suppose, hundreds of descriptions of such apparatus. It is certain that their mechanical simplicity, freedom from frictional errors, and capacity for accounting for the smallest currents are very great recommendations, but they have certain disadvantages. There is usually a serious fall of potential in the cell, and they are liable to corrosion and decay. The importance of the first point is greatly reduced by high potential distribution, and the second is a matter of degree and may be brought within small limits.

A very promising electrolytic prepayment meter, recently brought out, is, we understand, being used at Norwich. A prepayment meter is just a case where simplicity and cheapness are much more important than great accuracy over a large range and long running power. The sums of money collected are too small, and the installations too inconsiderable to pay for the use of complicated and expensive instruments, while the visits of the inspectors are so frequent that long-running meters are not required.

The principle of the Long-Schattner meter is very similar to that of the old Edison meter. Its form is clearly shown in our illustration.

Fig. 1 shows the principle diagrammatically. A is a lever pivoted at X. At the far end of the lever is suspended a

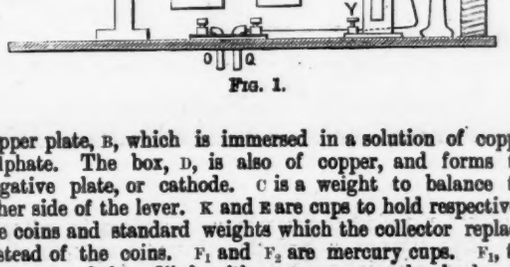


Fig. 1.

copper plate, B, which is immersed in a solution of copper sulphate. The box, D, is also of copper, and forms the negative plate, or cathode. C is a weight to balance the other side of the lever. K and E are cups to hold respectively the coins and standard weights which the collector replaces instead of the coins. F_1 and F_2 are mercury cups. F_1, the front one, being filled with mercury; F_2, the back one, being half filled with mercury and filled up with creosote oil. H_1 and H_2 are contact pieces forming a bridge across the mercury cups, which bridge is fixed on the lever. R_1 is a main resistance, across which the depositing cell goes as a shunt, and R_2 is a large resistance going from one mercury cup to the other.

Now, the total flow of current corresponding to a Board of Trade unit at 100 volts will deposit nearly ½ oz. of copper, so it is clearly out of the question to deposit copper in a small voltameter to correspond to the whole of the B.T. units which may be passed through the meter. The difficulty in this meter is met by shunting the depositing cell with another conductor, so that only part of the current passes through the cell. We should like some information as to the proportion between the two parts of the main current, through the cell and the shunt respectively, at different loads. The back E.M.F. of the cell, and there must be some, will cause a smaller proportion of the current to pass through it at low loads than at high; indeed, below a certain load when the fall of potential in the shunt is less than the back E.M.F. of the cell, we suppose that no appreciable amount of current will flow through it at all.

The plan of connections is shown in fig. 2.

When the lever is "up" it will be seen that the mercury connection in cup, F_2, is broken, and the current has to pass

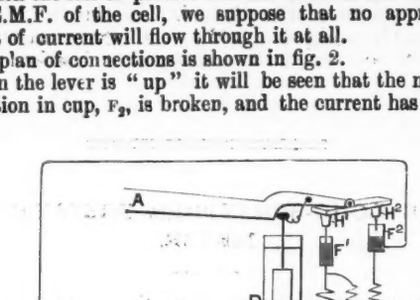
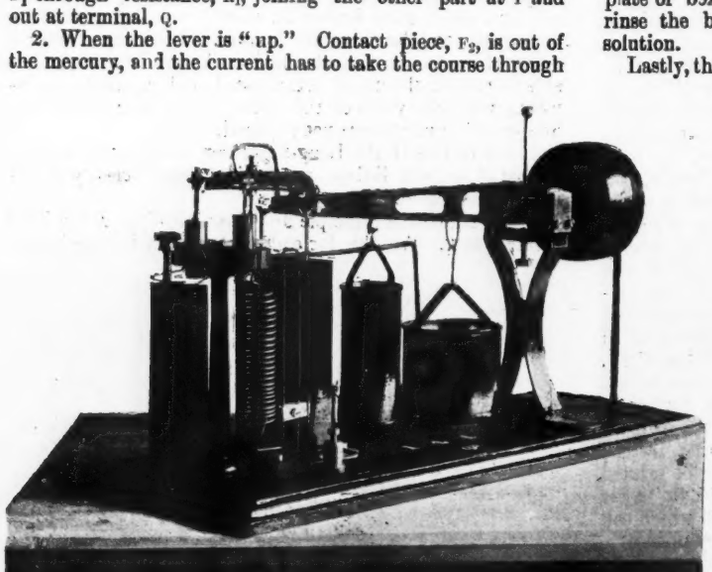


Fig. 2.

through resistance R_2. The course of the current is as follows:—

1. When lever is "down." Entering at O to mercury cup, F_2, H_2, from there part goes through connection to plate, B, across to box, D, depositing copper from B to D and out to Y; the other part, the main current, goes from H_2 to H_1, to F_1 through resistance, R_1, joining the other part at Y and out at terminal, Q.

2. When the lever is "up." Contact piece, F_2, is out of the mercury, and the current has to take the course through



resistance, R_2, which causes a very large drop in voltage; part again through R_1, and the other part up H_1 to plate, B and D, and joining the other part at Y again.

From the above the complete action of the meter can be seen. The lever is overbalanced, say, to start with. A coin has to be inserted, which brings the lever over again, establishing a short circuit across the mercury cups. It keeps in this state until the amount of electricity equivalent to that coin has been used, that is, until B is lightened enough to cause another overbalance, breaking H_2 and F_2, and forcing the current to pass through R_2; thus the circuit is never actually broken, the lamps continuing to burn quite dimly, forcing the consumer to insert another coin to get any appreciable light at all, whilst he has also to pay for the light he burns dimly, as that too goes as before through the depositing cell, so that the next coin he inserts really pays for that light.

R_2 is of considerable resistance; thus with 20 16-C.P. lamps a drop of about 70 volts is obtained; with 10 16-C.P. 35 volts drop; with five lamps, 17 volts drop; and with two lamps, about 7 volts drop.

For a room lighted with two lamps, a customer may prefer to buy some 93-volt lamps, and go indefinitely on tick with the lamps at their full pressure, to feeding the machine with the scarce threepenny bit or the useful sixpence. Of course, the current used while the lights are dim passes through the depositing cell, so that the next coin inserted goes to pay for that, and buys a smaller supply of the full light.

There are but few details to be explained. It has been found that the creosote in mercury cup, F_2, is very effective. It causes a perfectly sparkless "break" and "make," even at full load on a 220 volts circuit, and it also keeps the contact maker, H_2, perfectly clean. It, of course, does not deteriorate, neither does the mercury, so that the cups need really very little attention when working.

By never completely cutting the light off a great advantage is gained. It is distinctly one of the disadvantages of an ordinary prepayment meter that the consumer should suddenly be put in darkness. The way the Long-Schattner meter gets over that difficulty is unique, effective, and equitable to consumer and company. The consumer need not fear the annoyance of suddenly being put in darkness, whilst the company, on the other hand, is being paid for all the energy which is used.

One copper plate and box will last for 700 units, and then has to be replaced with a fresh plate and box, at a cost of 5s. The box and plate are made easily detachable from the meter.

It has been found beneficial to pour a thin layer of ordinary machine oil over the top of the copper solution, thus preventing any evaporation. This does not affect the plate or box at all, the only precaution necessary being to rinse the box and plate with water when removing the solution.

Lastly, the proprietors of the Long-Schattner patents have decided to make their meter purely a silver one, that is, only silver coins (3d., 6d., and 1s.) being admitted. They have come to the conclusion, from the experience of the gas companies as well as from other sources, that the consumer prefers a larger amount than a pennyworth at a time.

With each meter standard weights are supplied to cover the life of a plate, viz., 700 units at 6d. per unit, these weights to be gradually placed in the standard weights pan by the collector as he extracts the money.

The meters are calibrated to any required rate per B.T.U.

The copper sulphate solution is of 1,115 specific gravity, and is made up of 1 per cent. sulphuric acid and 99 per cent. water.

An instrument of this kind is not to be looked on in the same light as a Kelvin or Aron meter, nor is anything of the sort required. We think it is likely to prove very useful and to be just the rather rough, easily adjusted machine, that is wanted. Mercury cups with creosote, and voltameters with a layer of machine oil, are messy sorts of things, but they may work all right, are easily cleaned or replaced, and do not require a clockmaker to do it. It can, moreover, be seen by inspection whether the instrument is in order or not, a matter quite impossible with a motor meter, which may turn round and seem in good order, and yet be registering hopelessly wrong. A prepayment meter has to be visited at short intervals, and we are inclined to think the difficulties which undoubtedly are found with electrolytic meters may be less serious on this account with prepayment than with

recording meters. We are uncertain whether a prepayment meter requiring silver coin is quite desirable. It must be tempting to obtain your light on credit by putting pennies into a silver meter, while there is no temptation to advance money to a supply company by putting half-crowns into a copper meter. We all know how scarce small silver is compared with coppers. The demand for more than one pennyworth at a time is met just as well by putting in three pennies as a three-penny bit. We are less sanguine than the authors of the prospectus of the beneficial effects of the Long-Schattner meter on the human mind. They write: "Users of the penny-in-the-slot gas meters complain that with these coins they do not get their full value of gas, but with the Long-Schattner meter the complaint cannot exist." Some customers want their light for nothing.

It is claimed that with this meter there are avoided troubles that have been experienced with voltameter meters generally by (*a*) depositing away from the plate which we measure; (*b*) by bringing the current on to the plate at the top and out of the box at the bottom, and thus getting a very even distribution of current through the liquid; and (*c*) by the very low density of current there is no heating and there are no gas bubbles found. The result is a great accuracy at all loads. The loss of pressure across the meter is only—

·2	volt for	5	amperemeters	220	volts.
·2	„	10	„	110	„
·1	„	5	„	110	„

A FRENCH VIEW OF AMERICAN ELECTRIC TRACTION.

With a view to the adoption of electrical methods on the line now constructing between the old Orleans station and the new terminus, the Orleans Railway Company sent to America on a voyage of study a group of engineers, Messieurs Solacroup, Sabouret, Valton, and De Freminville and Hiberty.

Their notes are published in the *Revue General des Chemins de Fer*, and are of the customary excellent quality which distinguishes the work of French engineers. *L'Industrie Electrique* gives extracts from which we have endeavoured to cull. Our contemporary is brilliantly sarcastic at the expense of the Heilmann locomotive.

"While we are losing our time on the Heilmann locomotive, the Americans are utilising, with success, experience gained in exploiting electrical tramways in the development of electrical traction on main line railways—*leaving the generating station at home.*"

The sting of this, as of many other things, comes in the tail. The Heilmann locomotive, as we all know, does not leave its generating station at home; but—snail like—bears it on its back a constant load and encumbrance. Here we have a genuine French opinion of the wisdom of it.

In ten years electrical traction has almost entirely supplanted horse traction and cable lines in America. New lines have been established at the same time as electric lighting in small towns, in the suburbs of large towns, reaching out to distances impracticable for either horse or cable roads; uniting the principal localities at 40 to 50 kilometres apart, and endeavouring by the junction of suburban networks to raise up traffic between neighbouring towns. By the current year 20,000 kilometres had been constructed, and bid fair to grow still faster in the immediate future. And London is thinking of experimenting!!!

From tramway work main line work has been taken up simply by carrying out everything on a little larger scale. Though so new on main line work—scarcely three years—electric traction has already been applied, so far as the deputation were aware, to the tunnel of the Baltimore and Ohio, to certain branches and sidings at Hoboken, Newhaven, and Whitingsville, the Boston and Nantasket Beach, Hartford and Berlin, Berlin and New Britain, the Lake Street and the West Side Elevated of Chicago, Washington and Mount Vernon, Philadelphia, and Mount Holly, Norfolk and Ocean View, and on a little branch line of 5 kilometres in California.

We have repeated the list for the benefit of the London Metropolitan Railway, whose directors incompetently shiver between wind and water, afraid to venture, in their ignorance on the one hand, and fearful of rendering passengers too comfortable on the other hand.

The circumstances which compelled the adoption of electric locomotives in the Baltimore tunnel, in order to enable the company to compete for the New York traffic, are too well known to require any repetition from the French. The deputation observe that the service rendered is complete and regular. Electric locomotives alone haul freight trains also through the tunnel, and they note that all engineers, without exception, are satisfied. The third rail as a conductor has their approval rather than the overhead conductor, in that weight for weight copper has only from five to nine times the conducting power of steel, but it costs 1·05 franc per kilo, whereas steel rails (old) only cost 65 francs per ton (1,000 kilos). For other reasons, also, they approve the third rail. It appears to them a little out of the way to employ locomotives of 87 tons for a daily service of 15 trains when twice the number of trains might be worked with engines of half the weight; 22 tons per axle seems heavy. The engineers of the line consider, however, that the splitting up and re-forming of trains would be worse than the inconveniences named. They would also have preferred a simple reduction motor in preference to direct connection for such slow speeds as are employed, and an increase in the number of axles. By this change the motors could run so much faster and be correspondingly less.

But, on the whole, great satisfaction is expressed, especially in view of this being the first application to main line work and that the service rendered is double—freight and passenger—the four motors being coupled in series for heavy loads, while for passenger trains the working is in parallel of other locomotives since made by the General Electric Company, that of the manufacturers' line at Newhaven weighs 25·4 tons, and has two motors, one on each four-wheeled truck, driving one axle direct at 500 volts. At Hoboken a 25·8-ton engine has a geared motor to each of its four axles. This is highly commended.

With a total weight of train of 239 tons on a run of 1·76 kilometre in 3 minutes 17 seconds, the total energy consumed was 14·5 kw.-hours, or 34·4 watt-hours per ton kilometre.

The cost of production is ·0404 franc per kw.-hour. Adding 10 per cent. for line loss, gives ·044 franc (say, ·44d.). The electrical cost per 100 tons per kilometre is thus 1·54 franc, or practically 1½d., equal to 22 kilos. of coal. This includes all works' costs.

On the Berlin-Hartford line about 20 per cent. of the motors are off duty, which is declared small for machines doing their 570 kilometres per day. On the Nantasket Beach line, with 60-ton trains at 60 kilometres speed, the consumption of electricity varies from 37·3 to 50·8 watt-hours per ton kilometre. This is higher than at Baltimore, especially when it is considered that the line is nearly level, and at Baltimore the grade is considerable. But at Nantasket there are many stops—14 in 17 kilometres.

On the West Metropolitan of Chicago trains run at two minutes' headway. The motor cars weigh 26 tons, and draw during the daytime three trailer cars. The motor cars have two 125-H.P. motors, one on each axle of one of the bogies. The journey speed is 24 kilometres per hour at a cost of 77 watt-hours per ton kilometre. The motor cars are overhauled every 40,000 kilometres, or about every four months. This occupies three days; 6 per cent. are under repairs. The chief overhauling is that of the armature. Stations only average 600 metres apart.

The necessity of attracting passengers by high speed has led to the construction of new motor cars with four motors of 150 H P. in place of two of 125 H.P.—with a view, also, to hauling four trailers.

Full appreciation is awarded to the Sprague system of all motor car trains with synchronous working, whereby Mr. Sprague hopes to get up a velocity of 64 kilos per hour in 20 seconds, run at a speed of 90 kilometres, and employ 20 seconds in a brake stop, so securing on runs of only 500 to 600 metres, a journey speed of 35 kilos per

hour. Such is the order of ideas of American engineers. The French engineers see no further difficulty ahead, overhead or below the conductor is equally practical, and a third rail on blocks of paraffined wood is fully shown at Chicago to deal perfectly with trains of 108 tons on 2 minutes' headway. General forms have already been established, and all apparatus has been brought to a size beyond what is required for the heaviest trains in France.

No more can the electric locomotive be looked upon as experimental. Daily work over many months has demonstrated its superior tractive power over steam, and its reduced weight for equal power. Improvement, it is true, is still possible, but the electrical locomotive no longer requires inventing. It is there and has come to stay.

MR. RAWORTH'S PRESIDENTIAL ADDRESS TO THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

We always expect something sparkling from Mr. Raworth, and we are seldom disappointed. In a presidential address he is "all there," if so vulgar an expression may be permitted, and on this particular occasion he has fulfilled expectations. Some men have capital ideas, and are conscious of the possession of much wit, but they are quite unable to express those ideas intelligently, or put their wit effectively in use; while others, like Mr. Raworth, have ideas and wit, and exult in their ability to express them in clear, vigorous English, at all times and seasons. Perhaps, after all, it is as well that this is the case, else the prospect would be opened up of all talk and no work—a prospect not by any means conducive to peace of mind or progress.

As Mr. Raworth's address was published *in extenso* in these columns a fortnight ago, it is not necessary to quote his remarks at length, or even at all. But a brief review of the salient points of his address may not be uninteresting.

In his opening sentences Mr. Raworth was concerned—and we share his concern—to find that the Northern Society have experienced extreme difficulty in getting members to prepare and promise papers for this session. As an explanation of this, he assumed that they were too busy at work to spare the necessary time, and put themselves to the necessary trouble. We hope, and believe, that this assumption is correct, and this being the case, we are glad that indications all round point to the fact that the electrical industry is just now working at full load, so to speak. Only a cynic, of course, would suggest that the Society could not stand many talkers of the president's calibre; and as a Society, it is therefore content to let him do all the talking that may be required in its behalf.

But another reason, besides that officially given, may lie in the fact that the subjects set down for discussion at the Institution meetings and the M.E.A. Conventions are so comprehensive, that scarcely any are left for the Northern Society to deal with. Whatever the cause, however, it is to be hoped that the Society, composed as it is of so many brilliant and up-to-date engineers, may not grow enervated through lack of the mental sustenance which comes with the preparation and provision of papers on technical subjects, and the members might consequently be reasonably called upon to contribute their quota, even at the cost of some personal inconvenience.

Mr. Raworth, after metaphorically flapping his wings and executing a victorious crow in his own vigorous fashion over the prostrate body of his critic, the *Engineer*, proceeded to run lighting over the heads, not of his adversaries, but of the subjects connected with the departments on which development had been more or less strongly marked, and glanced at the principal influences which affected the rate of progress.

In the course of this expedition he stumbled across one point in particular which gave him pause, namely, that out of every £100 applied to electric lighting purposes, £37 per cent. went to the manufacturer of plant, "who made all the noise and held all the meetings," and £34 per cent. went to the manufacturer of mains, who apparently "made all the profit," and who, we may assume, did all the chuckling to himself. It will be interesting to hear what the manufacturers of cable have to say on this subject.

Traversing the paths of bygone years, Mr. Raworth came to the conclusion that if they had only taken care of the money which the public subscribed in the two years of the electrical "boom"—1882-3—they would never have had to ask for a single penny more in the whole of the 15 years that had since elapsed. A startling conclusion, truly. And yet there must be, and undoubtedly is, considerably more truth than fiction in it, for Mr. Raworth, engaged as he has been in the electrical industry for the past 20 or 25 years, a greater portion of which he has passed behind the scenes, speaks with the authority of experience.

One thing, however, is obvious: that, notwithstanding the immense improvements which have been made in the design of generating plant during the last decade, some of the pioneer plants gave almost as good results as some of the plants recently installed have given. Notably is this the case with the arc lighting plant installed at Blackpool in 1879 (Mr. Raworth himself being, we believe, the superintending engineer). This plant in 1892, after running continuously for 14 years, gave the splendid figure of 4·61d. per unit as the total cost, although supply was only provided during the season, a period of about 800 hours.

There is, unfortunately, occasion for pessimism as regards present-day expenditure on electrical plant. Those people who see with their eyes, and hear with their ears, are well aware that Mr. Raworth's statement is likely to be repeated with perfect truth 10 years hence. In the establishment of a new and a great industry like the electrical, it is, of course, impossible for mistakes to be avoided; but at the same time it would seem to us that if electrical engineers were oftener to sink some of their personal predelictions, and proceed more on standard lines, a considerable amount of money would be saved, and a great check to the more rapid progress of electric lighting would be removed.

In discussing facts and figures, Mr. Raworth is at his best. Few there are in the profession who have the same happy knack of making statistics palpitate with life. Perhaps his most striking success on this occasion was the statement that he had found that the 60,125,000 units which were sold last year could have been produced by no more than 20 1,000-kilowatt sets, working during factory hours; whereas the actual amount of plant employed was not less than 72,000 kilowatts. We have not been able to check these figures, but on the face of them they appear to be pretty near the mark. Allowing for a trifling error which may have occurred in his calculation, they still most luminously exhibit the greatest of all drawbacks to the financial success of electricity undertakings, the want of a day load; and if they serve no other purpose, they should impel station engineers to earnestly and energetically address themselves to the solution of this the most pressing, perhaps, of all problems before them.

Passing over the data relating to capital expenditure on electricity undertakings, to the number of provisional orders (145) with which nothing has been done, to the somewhat surprising fact that the annual cost of producing gas equals the total subscribed capital of the electrical industry, to the expenditure, for which there is little to show, on tramways, to the progress—or lack of progress—made in connection with electric launches and electric cabs, we come to Mr. Raworth's remarks as to the electrical distribution of power. Mr. Raworth regards, with evident satisfaction, the success which has attended the Bills of the Chelsea Company, the Metropolitan Company, and the General Power Distributing Company. We are, however, afraid Mr. Raworth's satisfaction will be short lived, and will cease to exist after the House of Commons' Committee have had an opportunity of discussing the almost revolutionary proposals which these Bills contain. The policy of "beggar my neighbour" may be all right for the beggarer, but is bad for the beggaree.

Probably nothing in Mr. Raworth's address will excite more interest—and controversy—than his remarks on what he calls the avarice of municipalities. Up to the present we have happily found ourselves in agreement with Mr. Raworth, but herein we have cause for dissatisfaction. We regret that with the extensive vocabulary which he has

always shown himself in possession of, Mr. Raworth was not able to find a better word than avarice to apply to the proceedings of municipalities. Gloss it over as he may, there is still an objectionable sound about it, and as such it will tend to stir up feelings of animosity in the breasts of town councillors, and make even the plain places rough in the paths of companies approaching them for concessions. In this respect Mr. Raworth has, in our opinion, committed a grave error of judgment, and he would be well advised in endeavouring to rectify this error at the earliest possible moment.

Looking at the causes which have apparently led Mr. Raworth to so express himself, we fail to see that the proceedings of municipalities deserve the construction he has put upon them. In the natural order of things, companies and municipalities must ever be at war. Companies exist and operate for the benefit of individuals, municipalities for the benefit of the body politic; and only by mutual concessions can progress be accomplished. It is idle to say that private enterprise is being killed, or may be killed, by municipal obstruction. Until we know Mr. Raworth's definition of municipal obstruction, we are at a loss to follow him.

Private enterprise, in the widest acceptance of the term, oftentimes means the creation of monopolies, and the world has seen sufficient of monopolies to regard them with anything approaching favour. In saying this, we are far from wishful to decry private enterprise. We are deeply sensible of, and we cordially acknowledge the beneficent influences and valuable results of private enterprise, which has, as it always has had, our heartiest support and best wishes. But we cannot blind our eyes to the fact that municipal enterprise, though lethargic as a rule, is, nevertheless, equally beneficial and valuable, and in the field of electric lighting and traction is, at all events, likely to be productive of as much good in the long run to the electrical industry generally as the most enterprising and resourceful of private companies.

Mr. Raworth quotes figures relating to gas undertakings owned by corporations and companies, and draws a comparison greatly to the disadvantage of municipalities. Unfortunately we have not, owing to lack of time, had an opportunity of perusing the returns from which the figures are taken; but unless Mr. Raworth has taken the sums set aside annually for sinking fund, depreciation, and reserve into account, and compared the cost of residuals in the districts he mentions, his figures cannot, in our opinion, be looked upon as at all conclusive, or as forming a sufficiently strong foundation for the structure on which he has built his fortress, and from which he has directed his thunderbolt.

CORRESPONDENCE.

Rotatory Converters.

The astonishing article on the above subject, which appears in your last issue, reads more like a piece of special pleading than the impartial consideration of an important subject which one might reasonably expect in a technical paper.

Those who are concerned in the employment of alternating currents have never, as far as I know, claimed that they could replace continuous currents for all purposes. On the other hand, though a few instances of long-distance transmission by means of continuous currents are actually at work, yet their very rarity surely shows that this branch of electrical engineering is essentially the domain of alternate current work.

Recognising, then, that each has its special field of usefulness, while there remains a large debatable territory where the employment of continuous or alternating currents is largely a matter of fashion, it is evident that any apparatus which permits of a conversion from one to the other must meet with numerous applications. It is true that if such converting apparatus had the low efficiences given in the article as a "rough estimate," their use would be exceedingly limited. But these figures are certainly very rough—on the converters and transformers. The writer of the article does not mention what size of apparatus he has in his mind, but if anything larger than mere toys is intended, the efficiency will probably be nearer 95 per cent. than the figure given. Transformers with an efficiency of only 90 per cent. might be useful as cooking apparatus, but would not be employed in practice for stepping up or down the tension of a transmission line. As to the efficiency of the latter, it will, of course, depend on its length, as well as many other considerations; but it is comparatively seldom that it is found advisable to admit such a large loss as 10 per cent. Even at less than full load the combination will have a far better efficiency than 59 per cent. In the case of an important contract recently given, the mean of the efficiencies at full, three-quarter, and half loads of the complete combination, consisting of step-up and step-down transformers and two rotatory converters, is guaranteed at 78 per cent.

The remarks about the "advent of the long-looked-for alternating motor" seem a little out of place in "this so-called nineteenth century." The alternate current motor, whether for single or multiphase currents has come, and come to stay. It may not, perhaps, be generally known, that in the city of Frankfort 1,400 H.P. of single-phase motors are running from the town lighting mains. The multiphase motor is in use from China to Peru, and in this country alone three railways and one tramway are being run with three-phase motors on the rolling stock; but there must always be a class of traction work where it would be desirable to employ continuous current motors on the cars, in order to take advantage of the series parallel connection for starting. For such work, then, the rotatory converter is likely to have an increasing field of usefulness.

A. E. Levin.

Baden.

Your correspondent misses the point of the article, namely, the introduction of complicated methods without any apparent good reasons in many cases.

I have not seen many really reliable independent results of tests which give better results than 90 per cent. on an all-round 24 hours' load, varying from zero to maximum during the time.

For certain purposes the alternating motor meets every requirement, but with the exception of long distance power work the continuous motor meets every purpose and all requirements. In Frankfort alternating motors are used chiefly because only alternating current is available—it is a case of "Hobson's choice." The conclusion of Mr. Levin's letter concedes all that the article argued for.

The Writer of the Article.

Direct v. Alternating.

I would ask the favour of space in your influential columns regarding a matter of considerable interest to the public in general, and to those concerned in electric engineering in particular.

The editor of one of our London technical journals devoted to electricity has been good enough to criticise my views with regard to direct current *versus* single-phase high tension alternating.

The universal plan in this country where the latter system is adopted, concisely put, I have never hesitated to state has resulted in a loss of two to three millions sterling, at least to investors, and to have been the direct cause of about 30 fatal accidents since its introduction into Great Britain.

On the other hand, if instead of having used that system, the same towns or districts in London had adopted the use of direct current, this unnecessary loss of life would have been avoided, greater prosperity to investors would have resulted, and the manufacturing industries' interests would have been most materially assisted.

Various industries could in that case have had the great advantage of cheap, convenient, intermittent if needed, electric motive power, against the extravagant, and for small industries, the inconvenient use of gas or steam engines.

This fact has at last been recognised by the City of London Electric Supply Company, Limited, and other companies who are now laying down plant and mains for direct current motors.

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The importance of the industry demands fair and genuine criticism regardless of the existence of any axes, and quite independently of how and where they should be ground.

A. L. Fyfe.

65, Angell Road, *November 19th*, 1898.

Brighton Breakdown.

Assuming the correctness of Mr. Tapper's explanation of this mishap, it is not easy to see *why* the seven uninjured dynamos did not take up the load again after the cut-out of the faulty machine had opened, and thereby removed, the short circuit from the system.

It would be of interest if he could give additional information on the following points.

1. How much time (approximately) elapsed after the short occurred before the cut-out of the faulty machine opened?
2. Of what type are the engines driving the other seven dynamos, and how are they governed?
3. How did these engines behave during the minute or so that elapsed between the occurrence of the short and the opening of the seven cut-outs?
4. Did these seven cut-outs break circuit approximately together, or not?

H. C. L.

High and Low Resistance Wires.

We are looking for a high resistance wire (about 50 times copper) with practically a zero temperature coefficient. We understand that there is such a material made either in England or on the Continent. Perhaps this wire is made by people whom your paper reaches. Can you aid us in any way in locating this material? The temperature coefficient of "Rheostene," "Constantan," "Kruppine," &c., is too high, while "Manganin" and "Eureka" are too low resistance.

We also want a wire of low resistance (as near to copper as possible) with a low temperature coefficient.

If you can put us in the way of getting either of these wires we would appreciate it.

Wilbur B. Driver & Co.

126, Liberty Street, New York.

X Ray Coils.

I am anxious to build a large coil for X ray work, capable of giving 18 to 20 inches spark. Could you, therefore, assist me by giving, through your paper, dimensions necessary to obtain this, as to length and size of core, quantity and size of primary, also quantity and size of secondary, and number and diameter of sections?

Coil.

LONDON COUNTY COUNCIL.

The proceedings at the weekly meeting on Tuesday are noteworthy from the fact that an attempt is about to be made to settle the differences between the Council and the National Telephone Company for the benefit of telephone subscribers

Tramway Purchase.—Borrowing Powers.

Although not of an electrical character, the question of the borrowing powers of the Council in respect of the purchase of the undertaking of the London Tramways Company is worthy of being recorded for the benefit of other local authorities. The amount required for this purpose is £860,000, and the Council asked the Treasury to consent to the repayment of the expenditure to be spread over 60 years in the case of £620,000, and 25 years for the remainder of the sum. In this connection, the Finance Committee reported that the Treasury authorities have given their consent to the expenditure, and to the proposed terms of repayment. With regard to the repayment of the £240,000 in 25 years, representing the value of horses, rolling stock, and plant, the Treasury authorities stated that they had felt some doubt whether a shorter period should not be fixed. Having regard, however, to the remunerative character of the undertaking, and understanding that in future "renewals will be charged to the revenue derivable from the tramways," the Treasury had decided to waive the point in question.

A New Telephone Move.

Mr. Beachcroft asked whether it was correct that 900 persons were waiting to join the system of the National Telephone Company. It was said that those persons were unable to get connected up because the Council refused to allow the company to place its wires underground. Were they to have to wait indefinitely?

Mr. J. W. Benn replied that it was true that in the development of the telephone system certain consents had been withheld. As the Council was aware, the company had not been granted permission to place its wires underground, because it had not seen fit to concede terms to London analogous to those ceded in other cities. The Highways Committee felt very much the inconvenience of those who were prepared to pay the present rates of the company. The speaker mentioned further that the committee had made arrangements to meet representatives of the National Telephone Company at an early date in order to see whether they could overcome the difficulty.

Gas Explosions in Street Boxes.

The Highways Committee reported that on the 5th inst., while some men in the employ of the Gas Light and Coke Company were laying a service in the Strand, near Norfolk Street, one of them drove a steel wedge into the low tension triple concentric main of the Metropolitan Electric Supply Company at that point, and so established a short circuit on the main. There was no fuse upon the main, but one of the gun-metal connectors in a footway-box at the corner of Clement's Lane became fused and opened the circuit, when the fire ceased. While the main was on fire the cover of a low-tension box adjoining the spot where the accident occurred was blown off, but it does not appear that this did any damage. The explosion was probably due to the ground being impregnated with gas, as the box had no connection with the main which was struck into.

It appears probable that the accident would not have occurred had the main been laid well below the underside of the concrete in the carriageway; and the Highways Committee stated that they proposed to recommend the Council to attach to its sanction to the laying of additional mains in that locality, a condition that they shall be so placed, or if that be found impracticable, that they shall have some external covering to protect them from accidental injury. The Committee had suggested to the company that in future when works are being carried out by gas or other companies in thoroughfares where it has mains laid, it should have a representative present to point out their positions, and so prevent their being interfered with or damaged accidentally in any manner. Another explosion took place on the 26th ult. in a street box belonging to the same company at the corner of Russell Street and Wellington Street, Strand. In this case no damage was done to person or property. The cause of the explosion could not be definitely ascertained, but it appeared to the Highways Committee to have been due to an accumulation of gas in the box, which was constructed some years ago. The Committee reported that they had given instructions for the attention of the company to be called to the necessity for some additional means being adopted for preventing the accumulation of gas in the boxes and conduits.

Lighting of Waterloo Bridge.

Colonel Probyn asked the chairman of the Bridges Committee when the public might expect to see Waterloo Bridge lighted by electricity.

Mr. H. Ward, in reply, stated that the Council was to a certain extent in the hands of the electric light company. The lighting was to be provided free of cost to the Council, and when the company had connected its mains, the inauguration of the lighting might be expected.

Overhead Telephone Wires.

The adjourned report of the Highways Committee was submitted with reference to the application of the National Telephone Company for permission to retain certain long span telephone wires in Islington. The Committee recommended that sanction should be given to the retention for 12 months of those overhead wires not exceeding 150 yards in span, and for six months in the case of those wires having a greater length of span.

Mr. Radford moved that the recommendation should go back to the committee to ascertain the wishes of the Islington Vestry on the subject. He said that the Vestry had required the company to remove the overhead wires, because they had been erected since the adoption of the bye-laws relating to aeriel conductors, and because the company had not forwarded to the Council and the local authority full particulars of the wires within one month of erection, as required by the regulations. The clerk to the Vestry had informed the speaker that unless the company complied with the bye-laws the Vestry would be compelled to take legal proceedings.

Mr. J. W. Benn, chairman of the Highways Committee, after hearing the statement made by Mr. Radford, agreed, with the consent of the Council, to take back the report for further consideration. There was no intention to disregard the wishes of the Islington Vestry, whose views, he hoped, would be forwarded to the Council.

LEGAL.

Elieson Lamina Accumulator Company.

In the Chancery Division on Saturday, before Mr. Justice Kekewich, the action in *re* Elieson Lamina Accumulator Company, Limited, the

Earl of Galloway *v.* Elieson Lamina Accumulator Company, Limited, came up on a motion for judgment in default of appearance in a debenture holder's action. Mr. Warrington, Q.C., and Mr. McSwinny were counsel for the plaintiffs.

Mr. Justice Kekewich said he had read the papers, and it appeared that counsel did not ask by the minutes to continue the manager. That meant that he would have to apply again for the continuance of the manager, if desired, as his appointment by the Court expired on January 31st, 1899.

Mr. Warrington said they hoped to sell as rapidly as possible, and if his Lordship would continue the manager until some time after the sale he should be glad.

Mr. Justice Kekewich: I think so. You had better throw it over the Easter vacation, until April 30th, that would be reasonable.

Mr. Warrington thought there ought to be an inquiry as to the debentures.

Mr. Justice Kekewich: Not only that, but I think there ought to be an inquiry as to the other charges. I have generally found it necessary, and it does not add to the expense. An inquiry as to other encumbrances I have found convenient in practice.

Mr. Warrington: It is proposed to sell at the present moment the business, stock-in-trade, book debts, and other assets, with liberty to apply in Chambers as to the other property. A sale was the only way to protect the assets.

Mr. Justice Kekewich said that he did not care to order a sale as a rule. The plaintiffs were entitled to a charge, but it was a charge which could not be effective.

Mr. Warrington: No. Your Lordship sees that at the time the money comes into Court the debentures will become due. They will become due on non-payment of interest very shortly.

Mr. Justice Kekewich: When?

Mr. Warrington: The interest is payable half-yearly, on June 30th and December 30th, so that the interest will become due on December 30th, and the principal money will become due three months after default. It will become only a question of the plaintiffs receiving their debentures out of the proceeds of the sale. If something is not done the assets will all disappear. It is desirable to sell the business at once as a going concern, and to sell the stock-in-trade at once, as it is likely to injure if kept for any length of time. Your Lordship can order the stock-in-trade to be sold at once, but it would be a serious loss to everybody to sell the stock-in-trade by itself. That would be breaking up everything. I submit, that there being a charge, your Lordship was the means of protecting the property. The debenture holders are entitled to a charge in virtue of the debentures.

Mr. Justice Kekewich: They are entitled to a charge.

Mr. Warrington: I submit that being entitled to a charge, your Lordship is entitled to make an order for sale, although it may be that they cannot be paid immediately out of the proceeds of the sale.

Mr. Justice Kekewich: I think I may go that far. This is goodwill and stock-in-trade—you only ask me to sell the business?

Mr. Warrington: Yes, that is all.

Mr. Justice Kekewich: Very well, Mr. McSwinny will alter the minutes.

Holophane, Limited *v.* O. Berend & Co.

In the Chancery Division, before Mr. Justice Kekewich, on Tuesday, the action of Holophane, Limited *v.* O. Berend & Co., Limited, was entered for trial. Mr. Jessel was counsel for the plaintiff company, and Mr. Cann for the defendants.

Mr. Jessel said the action was for infringement of patent, and at the last moment the defendants had agreed to submit to an injunction and pay the costs, the plaintiffs waiving their claim for damages. He asked his Lordship to issue an injunction, and for two things besides, first, a certificate that the plaintiffs' particulars of breaches were reasonable and proper, and, secondly, a certificate that the validity of the patent had come into question.

Mr. Justice Kekewich: I am bound by the authorities.

Mr. Jessel submitted that the authorities were in favour of granting the certificates. Defendants admitted that they did threaten and did intend to put on the market a globe which they now admitted was a breach of the Holophane patent, in fact that admission was in the pleadings. On the authority of the Pneumatic Tyre Company *v.* Parr, tried by Mr. Justice North in 1896, the learned counsel contended that the judge had power, under Section 29 of the Patents' Act to certify, on satisfying himself that the plaintiffs' particulars of breaches were reasonable and proper, even had there been default of appearance; but in the present case the defendants, by appearing by counsel and admitting the plaintiffs' rights to an injunction, admitted that there were breaches. When the plaintiff not only did not run away but fought you, and only gave in at the very last minute—the case was settled only an hour or two before—in order to save expense, the Court had jurisdiction to certify. His case did not stop there. One of the principal grounds of defence was anticipation of patent by a gentleman named Trotter, an electrician of great eminence, who was now engineer at the Cape. His evidence had been taken on commission and did not support the defendants' contention, now abandoned, that his own patent anticipated the Holophane; he said it was outside the Holophane patent altogether. Considerable expense had been entailed in going out to the Cape, and they might take it that the defendants had come to the conclusion that they could not resist the action. So that really there was no reason for withholding the certificate which his Lordship would have given if he had put one witness in the box, and counsel for the other side had said that he could not carry the case further. There was only one case he could find, a judgment by Mr. Justice Kay, which went against his contention that the plaintiffs were entitled to a certificate that the validity of the patent had come into question, and that was on the ground that there was no appearance.

Mr. Justice Kekewich: How do you propose to draw up your injunction, "After hearing counsel, and defendants submitting to an injunction"?

Mr. Jessel: Yes, my Lord.

Mr. Justice Kekewich: Then your certificate will not be worth anything.

Mr. Jessel: "Feeling themselves unable to resist an injunction."

Mr. Justice Kekewich: That is not our form.

Mr. Jessel: No, but it would be true. There was a mass of evidence taken on commission on the file, which supported the plaintiffs' case. Sometimes a certificate would be refused where there was a possibility of collusion, but there was no suspicion of the kind in that case. It had been fought out to the very last moment, and was defended both on the action and on the original motion.

Mr. Justice Kekewich: Mr. Cann, do you submit to an order on these terms?

Mr. Cann: Yes, my lord. I have come to an arrangement with the plaintiffs, and there is an honourable understanding that I should abide by your Lordship's decision upon this point of certifying.

Mr. Justice Kekewich, in delivering judgment, said an injunction would issue on the terms agreed upon. As to the certificates which he was asked to grant, he said without hesitation that the tendency of the Courts had been to refuse a certificate unless the Court was first satisfied, as it could only be by hearing witnesses and examining documents, that the certificate ought to be granted. He was asked to certify that the plaintiffs' certificates of breaches were reasonable and proper, without understanding them, without knowing how far they could be proved or might fail. That was not a proper exercise of judicial functions. As regards the second certificate for which he was asked, that the validity of the plaintiffs' patents had come into question, he asked himself why that certificate was wanted. It would not increase the costs payable to the plaintiffs now, but it would enable them on another action if they won, as they might win, without doing more than filing a statement of claim against a defendant who did not appear, to tax costs as between solicitor and client. That was a very great advantage to a patentee, and plaintiffs sought to obtain it in a case in which, so far as his Lordship knew, if it were fought out the Letters Patent might prove to be invalid. His Lordship did not think that in a case where invalidity had been pleaded, and at the last moment the defendants submitted, he ought to grant a certificate. While agreeing with the statement that there was no collusion here, such a course might open a door to possible oppression of other defendants. On those grounds the certificates must be refused.

Judgment accordingly on the terms agreed upon.

Dublin Corporation *v.* Todd, Burns & Co.

On 18th inst., plaintiffs appeared in answer to an adjourned summons for having on October 10th placed an electric lighting cable overhead across Mary Street without the consent of the complainants and contrary to the provisions of Section 82 of the Dublin Corporation Act, 1890. The wires had not since been removed, whereby the defendants were stated to be liable to a penalty of £5 and to a daily penalty not exceeding 20s. Mr. Gerald Byrne, for the defendants, said his clients had been in communication with the Corporation, and there was a probability that they would supply the light. He asked that the case should be allowed to stand generally. The Corporation had also practically agreed to allow them a short time to complete their arrangements.

The matter was adjourned *sine die*.

BUSINESS NOTICES, &c.

Agency Notice.—The Unbreakable Pulley and Mill Gearing Company, Limited, has appointed Mr. William R. Harrison, M.I.M.E., Burnett Avenue, Scale Lane, Hull, sole agent for the sale of its "Unbreakable" pulleys and mill gearing, for Hull and suburbs.

Boiler Accidents.—With reference to the unfortunate boiler accident at Messrs. Siemens's works at Woolwich, by which two men were scalded to death owing to the blow-off cock of the boiler in which they were working being left open, and the blow-off cock of another boiler having been opened so that the boiling water and steam rushed into the standing boiler, Messrs. J. Hopkinson & Co., of Huddersfield and London, write stating that their patent isolating blow-off valve was specially designed to prevent accidents of this character. With these valves it is impossible for the water blown off from one of a series of boilers to be turned into an empty boiler. They are absolutely automatic in their action and require no attention. Messrs. Hopkinson also make isolating valves to prevent similar accidents through the steam or stop valve being opened on a standing boiler. We are of opinion that it should be made compulsory to use boiler fittings having for their object the prevention of such accidents. Messrs. Hopkinson have sent us a pamphlet on "Improvements for the Safer Working of Connected Steam Boilers."

Boiler Plant.—Messrs. John Fraser & Son, of Millwall Boiler Works, E., have put down a new hydraulic plant suitable for large marine boilers, and also other additional machinery. Their name has been placed on the Admiralty list of contractors who may be asked to tender for the construction of cylindrical boilers up to 14 feet in diameter.

Electrical Wares Exported.

Week Ending Nov. 22nd, 1897.	£	s.
Alexandria. Teleg. mat.	58	0
Amsterdam	40	0
Antwerp	120	0
„ Elec. fuses ...	574	0
Bangkok	51	0
Barbadoes	16	0
Barcelona	10	0
Bombay	10	0
Brisbane. Teleg. mat.	8,803	0
Calcutta	511	0
Cape Town	1,057	0
Channel Islands ...	12	0
Cologne	15	0
Colombo...	379	0
Durban	464	0
East London	810	0
Flushing	15	0
Fremantle	4,597	0
Gibraltar	94	0
Gothenburg	42	0
Hamburg	289	0
Madras	50	0
Malta. Teleg. mat. ...	90	0
Melbourne. Teleph.mat.	1,114	0
Naples	45	0
Ostend	400	0
Panama	17	0
Rotterdam. Teleg. mat.	47	0
Shanghai	15	0
Singapore	61	0
Sydney	436	0
Townsville	390	0
Vera Cruz	20	0
Wellington	858	0
„ Teleg. mat.	550	0
Yokohama	290	0
Total	£21,854	0

Week Ending Nov. 22nd, 1898.	£	s
Adelaide	73	0
Amsterdam	61	0
Bombay	140	0
Boston	45	0
Brussels	30	0
Buenos Ayres	100	0
„ Teleg. mat.	704	0
Calcutta	500	0
„ Teleg. wire...	329	0
Cape Town	54	0
Christiana	460	0
Colombo	81	0
Copenhagen	84	0
Durban	2,246	0
East London	151	0
Gothenburg	103	0
Hamburg	110	0
Hong Kong	122	0
Launceston	90	0
Madras	38	0
Malta	157	0
Melbourne	75	0
Ostend	10	0
Penang. Teleg. mat. ...	118	0
Port Elizabeth	73	0
Quebec	100	0
Rio de Janeiro.... ...	32	0
Rockhampton... ...	303	0
Rotterdam. Teleg. mat.	107	0
Senegal. 55 knots teleg. cable	107	0
Shanghai	93	0
„ Teleg. mat....	1,087	0
Singapore. Teleph. mat.	58	0
Stockholm. Teleg. mat.	189	0
Sydney	1,023	0
Tientsin. Teleg. mat.	79	0
Vera Cruz. Teleg. mat.	33	0
Wellington	32	0
„ Teleph. mat.	381	0
Yokohama	434	0
Total	£9,905	0

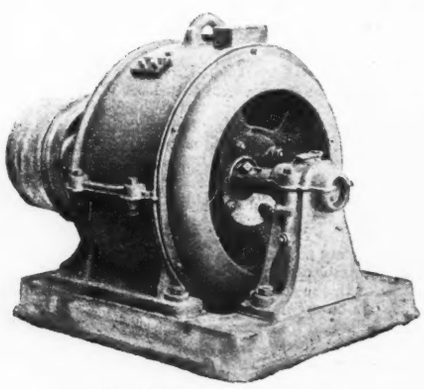
Dissolution of Partnership.—Messrs. F. C. Craig, H. C. Voss, and E. Craig (H. C. Voss & Co., cycle makers, electrical engineers, &c., Seaham Harbour), have dissolved partnership. Debts will be received and paid by H. C. Voss.

Liquidation Notices.—On November 14th the United Ordnance and Engineering Company, meeting at 99, Cannon Street, E.C, resolved to wind up voluntarily as it could not continue by reason of its liabilities. Mr. W. E. Davies, Broad Sanctuary Chambers, S.W., was appointed liquidator.

Creditors of Messrs. Rose & Bird, Limited, should send particulars of debts or claims, &c., to the liquidators, Mr. C. Walker, of Mayfield, Potter's Bar, and Mr. A. H. Rose, of 24, Stamford Street, Blackfriars, on or before December 9th.

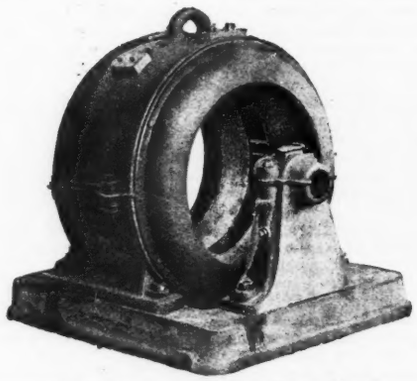
A meeting of the Times Electric Lamp Company, will be held on Wednesday, December 21st, at Swan House, Great Swan Alley, E.C., to hear an account of the winding up by the liquidator, Mr. J. Lewis Lewis.

Alternating Machine with Revolving Inductor.—Messrs. Fabius Henrion, of Nancy, make this machine for special cases—high-speed machines, &c. The armature, fixed, is formed of two crowns consisting of sheets of iron insulated from one another. The induced wires cross these two crowns from side to side in



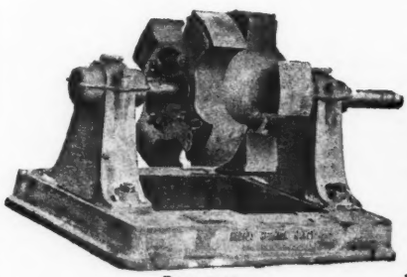
The Complete Machine.

tubes of micanite completely closed. The field magnet is one massive piece, and the magnetising bobbin is immovable in the middle of the machine. The only movable part of this machine, like others with revolving iron, is a piece of cast-steel, but it is claimed to be far superior to others of the kind. Up to now each crown in machines



Armature Wires passing through Tubes Embedded in the Sheet Iron Crowns.

with revolving inductors had its own winding, and the outlets of their wires, in the middle of the machine, could not be tested. Thus, dust collected, which it was almost impossible to remove, and which



Inductor (the only Movable Part).

Fixed Magnetising Bobbin.

affected the insulation. In these machines, on the contrary, the wires pass from one crown to the other in a tube of micanite without any break; they are thus perfectly protected throughout their length. This arrangement does away with all the wires coiled uselessly between the two crowns, which can thus be brought close together. The length of wire in the armature is thus diminished, and consequently its resistance.

Applications for Provisional Orders for Electric Lighting and Trams.—The *London Gazette* for November 18th, contains notice of the following applications for provisional orders for electric lighting:—East Barnet Valley District Council, Horsham Urban District Council, Audenshaw Urban District Council, Heywood Corporation, West Kent Electricity Supply Company (parishes and places in the County of Kent), Halesowen Rural District Council, Ashford Urban District Council, Fenton District Council, Weston-super-Mare and District Electric Light and Power Syndicate, Stourbridge Urban District Council, Bognor Urban District Council, Birmingham Corporation (purchase of company's electricity undertaking), Pemberton District Council, St. James's and Pall Mall Electric Light Company, Limited (purchase of land at St. James's, Westminster; erection of generating stations, &c., &c.).

The following applications for tramway and railway powers include clauses relating to the employment of electricity:—Blackpool Corporation (alterations and extensions); City and Brixton Railway Company (further powers); Audenshaw Urban District Council; Bradford Corporation; Halifax Corporation.

The *London Gazette* for November 22nd, contains the following further notices:—

Electric Lighting—Ryde Electric Light and Power Company, Ltd., boro' of Ryde; Manchester Corporation (powers to purchase and let on hire electric motors and other apparatus); Leicestershire and Warwickshire Electric Supply Company (for supplying part of the counties of Leicestershire, Warwickshire, and Derby); Blackpool Corporation (various electric lighting and tramway powers); Stockport Corporation; Rawtenstall Corporation; County of London and Brush Provincial Company (various powers *re* Wandsworth, Camberwell, St. Luke, Middlesex, and numerous other places); Kensington and Knightsbridge Electric Lighting Company, and Notting Hill Electric Lighting Company (powers for sundry provisions, agreements, &c.); Maerdy Electric Light Company (for the parish of Ystrad-y-Fodwg, Glam.); Cheriton Urban District Council; Mansfield Corporation; Loughborough Corporation (purchase of gas undertaking, and powers *re* electric lighting); Camborne Electricity Supply Company, Ltd. (Camborne); Central Electric Supply Company (powers and works in Marylebone); Slough and Datchet (powers to Messrs. Laing, Wharton & Down); Failsworth District Council; Walker and Wallsend Union Gas Company (electric light-

ing powers); Worksop District Council; Crowborough Gas Company (electrical powers); South Lancashire and Cheshire Electricity Company (part of the counties of Lancaster and Chester); Whitehaven Corporation (extension of electric lighting area); Lancashire Electric Power Company (parts of Lancaster and Chester); Newport (I.O.W.), powers to Ventnor Electric Light and Power Company; Blackheath and Greenwich District Electric Light Company (Blackheath and Greenwich); Swinton and Pendlebury District Council; Durham Corporation.

Electric Traction.—Gravesend, Rosherville, and Northfleet Tramways Company, construction of additional trams, electrical working, sale to Drake & Gorham Electric Power and Traction Company; Nottingham Corporation; North-West London Railway (underground electric from Marble Arch to Cricklewood); Oldham Corporation (various tramway powers for Oldham, Royton, Crompton and Lees, including agreements with interested bodies); Newcastle-upon-Tyne Corporation; Great Northern and Strand Railway (underground electric from Wood Green to the Strand); Baker Street and Waterloo Railway Company (extension of time and other provisions *re* underground electric railway); South Staffordshire Tramways Company (powers *re* leasing of tramways and use of electricity, &c.); Manchester Corporation (agreements with outside authorities *re* trams, also *re* electricity); Great Yarmouth Corporation trams; Darwen Corporation (construction of trams, electrical working, and various provisions *re* electricity); Wolverhampton Corporation (powers *re* construction of trams, supply of electricity outside borough, &c.); Bexhill and St. Leonards (powers to British Electric Traction Company to construct electric tramroads); Derby Corporation (purchase of trams); Southport Corporation; Ipswich Tramways Company (new lines, use of electricity, and sale to Drake & Gorham Electric Power and Traction Company); Sunderland Corporation, tramway and other electrical powers.

Books Received.—*Dizionario Tecnico in quattro lingue* IV., Inglese, Italiano, Tedesco, Francese, by Ing. E. Webber.

Nichelatura, by Ing. I. Ghersi.

L'Alluminio, by Dott. C. Formenti.

Colorazione e decorazione dei Metalli, by Ing. I. Ghersi.

All the above are published by Ulrico Hoepli, Milan.

Catalogues, Lists, &c.—Messrs. Connolly Bros., Limited, have brought out a new list (October) of their vulcanised rubber electric light and power cables, pure India-rubber ditto, aerial conductors, flexible cords and cables, concentric cables; also numerous other lines of their manufacture for electric lighting, bell, telephone, and telegraph work. Messrs. Connolly are extending their buildings and offices to cope with increasing business.

A list (new and revised) of ornamental switch covers has been issued by the Waltham Engineering Company. There are some pleasing designs illustrated. The company, which has just opened new showrooms at 46, York Street, Westminster, is fitting up a number of London hotels with metal work for illuminating and decorative work, including the "Bath and Cheltenham," the "Norfolk Square," the "Golden Cross," "Shelley's Hotel," &c.

Messrs. W. F. Dennis & Co., of Billiter Street, E.C., send us a copy of a new catalogue of telephones and accessories made by the Antwerp Telephone and Electrical Works, for whom they are London agents. Among the numerous articles illustrated and priced are ordinary, domestic, fancy, desk, and table telephone sets, generators and extension bells, switches, receivers, switchboards, and portable testing sets.

Messrs. Ward & Goldstone, of Chorlton-on-Medlock, Manchester, have issued a price list of insulated high conductivity copper wires for electric lighting, power, telephone, and other work.

We have received a number of lists relating to electrical manufactures of German firms, from Messrs. Pollard & Co., of Newcastle-on-Tyne, who are representing the different firms over here. Carbons for various purposes made by Sachsische Bogenlichtkohlenfabrik, of Mulda, Saxony; the Volta dynamo brushes made by Chr. Wandel, of Reutlingen, Wuerttemberg; incandescent lamps and reflectors, manufactured by Deutsche Elektricitäts-Gesellshaft, Köln-Nippes; lamp holders, switches, fuses, fuse blocks, wall contacts, and other fittings for incandescent lamps as manufactured by Messrs. Willing and Violet, of Berlin; also arc lamps for continuous and alternating current, search lights for photographic, theatrical, and coast defence purposes, made by August Schwarz, of Frankfort. These are among the various German firms and manufactures of which Messrs. Polland have taken up sole agencies. We also understand that they have been appointed agents for the Deutsche Kabelwerke, of Rummelsbergbei, Berlin, and for Paul Hardeyer & Co. (telephones and bells).

Mr. G. A. Nussbaum has recently published a general catalogue of telephones, telephonic apparatus, switchboards, accessories, &c., manufactured by La Société Industrielle des Telephones for which he is agent over here. There is a large number of excellent illustrations, a special enamelled paper being used to help in the printing. We cannot afford space to mention the numerous apparatus in detail, but we recommend the book to the attention of the trade. Ader-Bailleux, Berthon-Ader telephone sets, are described, and diagrams shown giving internal and external connections in each case. Indicators, switches, switchboards, relays, and accessorial parts, are shown in great variety, prices being also stated. Mr. Nussbaum also issues this catalogue in three separate sections, dealing respectively with telephones, switchboards, and accessories.

Changes of Address.—The Notting Hill Electric Lighting Company, Limited, notify their removal to new offices, at 140, High Street, Notting Hill Gate, adjoining the works, rendered necessary by the rapid increase of business.

Messrs. John J. Griffin & Sons, Limited, manufacturers of electrical and galvanic instruments, &c., have removed from 22, Garrick Street, and 2, Long Acre, W.C., to 22-26, Sardinia Street, Lincoln's Inn Fields, W.C.

Messrs. Ruston, Proctor & Co. notify that on and after 28th inst. their London office will be removed from 20, Budge Row, Cannon Street, to Stafford House, 27A, Cannon Street.

Cox-Walkers.—We understand that Messrs. Cox-Walkers are just completing a large electric light and motor installation at the new Academy, for the Leith School Board, where they have also fixed a large number of telephones, &c. A very complete installation of electric light, water-pumping motors, and various other electric appliances, has also been recently finished by them at Faverdale, for Mr. C. H. Backhouse, and long telephone lines, overhead and underground, with complete apparatus, at Loch Rosque, Achnasheen, for Mr. Arthur Bignold. The demand for telephones has necessitated extension of premises.

Diary, 1899.—The *Indian and Eastern Engineer* Diary for 1899 contains a great deal of new statistical data not given in previous editions. The book, which is before us, cannot fail to be of considerable interest and assistance to the engineer or commercial man having business connection with our vast dominions in India. The combination of a collection of useful information, such as is here gathered together, with an office diary, renders the book a good desk companion.

Electric Lamp Business.—At the statutory meeting of the Crystal Electric Lamp and Rose & Bird, Limited, which was held on the 10th inst., we are informed that the chairman congratulated the shareholders on the satisfactory increase in the orders received since the amalgamation of the two companies (the Crystal Electric Lamp Company, Limited, and Rose & Bird, Limited). The factory at Bedford is working at full pressure, and in order to cope with orders they had been compelled to increase the apparatus and machinery. The company has one of the first, if not the first, lamp factories in the kingdom, replete with every modern improvement. The chairman mentioned that the company's books exhibit a very representative and satisfactory list of customers numbering some 500, including H.M. Government, the Admiralty, the War Office, the Post Office, &c., and numerous corporations and electricity supply companies and contractors.

Electric Lighting of Brickworks.—An electric lighting installation is to be put down at the Saxon Brickworks, and a proposal is on foot to extend it to the town of Whittlesea if the local authorities will take the matter up.

Electric Organ Blowing.—A correspondent sends us some further details regarding the new organ which has just been inaugurated at Lincoln Cathedral, and to which we referred last week. There are for the organ three different pressures of wind, and for these three motors are necessary, one for each pressure. Each motor keeps the wind reservoir full at the requisite pressure, and the moment the reservoir begins to empty by the wind being used, a specially-designed automatic gear comes into operation and starts the motor running. The motors are of 3-H.P., 1½-H.P., and ¾-H.P., respectively. They are started by a single handle near the console, and all the organist has to do is to switch off the current when he has finished. At the opening of the organ no less than 14 men were required to take the place of the current, and the cost of blowing by electricity, using the full organ all the time, at the present price proposed to be charged by the Corporation will be about 1s. per hour. All is ready for the current but the making of the connections. The firm of Messrs. Bergtheil & Young, who did the electrical work, are represented in Lincoln by Mr. Eccles.

For Sale.—The Glasgow Corporation is inviting offers for the purchase of two engines and boilers, and four Brush arc light dynamos. See our "Official Notices" this week.

Fraud.—At the Devon Assizes last week E. J. Thomas, an electrical engineer, was sentenced to 12 months' hard labour for obtaining credit from various firms by means of false pretences.

Low Resistance Leclanché Batteries.—Nearly seven years ago the General Electric Company, Limited, introduced their "Carporous" Leclanché Cell, No. L. 1,220. This cell was the result of investigations undertaken with the view of producing a form of Leclanché cell having the advantages of complete depolarisation while in work, reduced internal resistance, increased constancy and long life, increased useful capacity, immediate activity after charging, and no creeping. In the "Carporous" cell the porous pot is made of an inner perforated porous, and an outer carbon cylinder. This "Carporous" pot contains the depolarising peroxide of manganese mixture, and serves as an insulator for the zinc rod, which is in the centre. This cell is No. L. 1,210. Later this development was rapidly followed up by the three forms of "Sack" cell, No. L. 1,216. In these the "Carporous" outer perforated carbon cylinder was replaced by a sacking tube. A further improvement, the "Carsak" (Regd.) cell is now introduced, and we have received a copy of a circular which the company has issued concerning same. In this battery the negative element is a porous cell, containing the necessary proportions of carefully selected carbon and manganese granules, packed together and held in position by a cylinder of sacking. For safety these "Carsaks" are sent out protected by a waxed cardboard sheath, which should be withdrawn immediately before immersing, and on no account before, as the material of which the sack is composed is highly hygroscopic. The positive element in larger sizes is a specially constructed cylinder of zinc, of guaranteed 98 per cent. purity, and thoroughly amalgamated. In a smaller size it is a rod of equal quality zinc, as used in ordinary Leclanché cells. The containing vessel used for the larger sizes (0 and 1) is a cylindrical glass jar, a lipped jar being used for the smaller size. The battery can be seen

at the company's offices, 71, Queen Victoria Street, E.C. Several hours' light can be given by means of the large size "Carsak" cells, and for substitution of bichromate batteries the battery seems very suitable, as it gives very large current output, and, of course, it is not necessary to always remove the zincs when it has finished work.

New Premises.—Messrs. Gambrell Bros. have opened premises at 17, Giltspur Street, E.C., as electrical engineers, &c.

Water Power.—In a recent address to the Royal Scottish Society of Arts, Mr. A. Beatson Bell mentioned a proposal which was on foot to establish electrical works on a very large scale near Ballachulish. He thought it highly probable that within the next few years the great tidal currents at the mouths of the salt water lochs of the West Highlands might be utilised, in addition to the fresh waterfalls at present alone employed.

It is stated that a Bill will be presented to Parliament next session to secure powers for the Loch Leven electrical scheme. The object of the project is to utilise the waters of Loch Ericht, along with the waters of other lochs to the head of Loch Leven, 20 miles distant. Loch Ericht covers an area of 7½ miles, and the water passes into the valley of the Tay through Loch Rannoch. The diversion is to be effected by means of tunnels and aqueducts. In the direction of Loch Eilde Mory the head of water will be broken into two falls. The industries likely to be attracted by cheap electrical power are those of chemical and allied trades. The scheme has been formed by Mr. George Anderson, civil engineer, Edinburgh. It will cost at least a million pounds.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—The Public Lighting Committee last week approved of a new agreement for two years with the electric lighting company. The company receives £17 17s. per lamp instead of £20 as formerly.

Alloa.—The Burgh Commissioners have now applied for a provisional order, and the proposed area includes Bank Street, Mill Street, High Street, Primrose Street, Drysdale Street, and Marshill.

Ashford.—Messrs. Stevens & Barker, of Maidstone, have just completed an electric light installation at the new Sanitary Steam Laundry at Ashford. There are 45 lights of 16 and 32 C.P., the ironing also being done by electricity.

Austria.—A large central station has just been completed and put in operation in the town of Trieste. The plant, which has been supplied by Messrs. Ganz & Co., of Buda-Pesth, comprises five large boilers of the Tischbein type, two 300-H.P. tandem compound engines, and two 220-kilowatt three-phase alternators.

Barnsley.—The British Electric Traction Company has given notice to the Town Council that it intends applying to the Light Railway Commissioners for an order authorising the construction of light railways in the borough. The Council has replied that it will oppose the application, as it has not yet decided whether to allow a company to come in.

Bermondsey.—In connection with the refusal of the Vestry to sanction the laying of mains by the London Electric Supply Corporation in certain streets, the Electric Lighting Committee reported to the Vestry on Monday that at the Board of Trade inquiry the company produced the written consent of the London County Council to the carrying out of the works. The committee stated that this was the first time that they were aware of the action of the Council in this respect, and they expressed the opinion that the Council should ask the views of the Vestry before sanctioning any works in the district. Mr. Cox, chairman of the committee, formally recommended that the County Council should be so informed. After some discussion the recommendation was adopted.

Birmingham.—A meeting of the City Council was held on Tuesday to consider the draft of a Bill authorising the transfer of the undertaking of the Birmingham Electric Supply Company, Limited, to the Corporation. The Lord Mayor, Alderman Beale, moved a resolution approving of the Bill, and stated that they had to give the company £400,000, and they had asked the company not to increase their capital, as that would increase the goodwill on which the city would have to pay. Mr. Howard Lane suggested that the considerations of the sale should be £120,000, as that was the amount paid by the proprietors of the company, and that a bonus of 20 per cent. should be offered to the proprietors. He thought the Bill should have been in a different form, and he declared that he had too much respect for his own conscience, and the feelings of his constituents, to support the Bill. The Lord Mayor said that the sales of the company were increasing, and if they let the matter go now, they would not again get it for the price. The draft Bill was approved.

Bournemouth.—Last week the Town Council referred a letter from the Bournemouth and Poole Electric Light Company, asking for consent to a provisional order about to be promoted by them, to the General Purposes Committee.

Buckley.—The proposal that the Urban Council should make application to the Board of Trade for a provisional order has been defeated by a majority of one.

Burnley.—A Local Government Board inquiry was held on 17th inst. into an application by the Town Council to borrow £10,000 for electric lighting. It was stated that the works had been profitable from the start, yielding a surplus of £500 a year. £25,000 is already being spent in extending the works and plant, and now £10,000 is needed for new mains.

Buxton.—The Council will apply to the Local Government Board for a £5,000 loan for the extra work required according to Prof. Kennedy's report.

Christchurch.—At the recent meeting of the District Council a representative from the Bournemouth and District Electric Lighting Company attended and asked the Council to give consent to a proposal to lay electric cables from the boundary of the Pokesdown Urban District, adjoining Bournemouth, to Christchurch. Sanction was given on certain conditions, which were accepted.

The City Lighting.—Last week while the Court of Common Council was discussing whether it was in a position to grant permission to the Metropolitan Electric Supply Company to come into the City area and compete with the City of London Electric Lighting Company, the latter company's supply was causing the greatest possible annoyance to consumers. The offices of the ELECTRICAL REVIEW are, unfortunately for us, taking current from the mains of the City Company, and on Thursday last week, when London was enveloped by a not uncommon November fog, it was no easy task to read proofs under a nearly new 8-C.P. 100-volt lamp. The complaint was general throughout the City. A consumer in Upper Thames Street writes to the *City Press* to send up "a wail of complaint," as he calls it, respecting the disgraceful manner, &c., &c. He says that during the fog last week the light was about equal to a tallow candle of the Georgian era. He adds that if the City Company cannot do better, it is time that the citizens took means either to revert to gas, or to break down the existing monopoly. At the Mansion House Justice Room Mr. Alderman Samuel Green, although every available light was on at the time, complained that he could hardly see what he was doing. From a consumer's standpoint, there is no doubt about it, that the City of London supply is most unsatisfactory, and the City Company seems to be taking advantage of the fact that the City man is, generally speaking, too much occupied about business matters to waste time agitating. There is a growing feeling in the City that the City Company's agreement with the late Commissioners of Sewers giving the company a monopoly for many years to come should not have been entered into. But that a monopoly exists, and that the Court of Common Council has no power to introduce competition, or allow it to be introduced, seems to be pretty clear to the mind of the Council, for it decided last week to inform the Metropolitan Electric Supply Company that it "regretted that it was unable to give its consent to the proposed application for a provisional order." In the course of a discussion which followed the moving of this resolution, Mr. Brooke-Hitching moved as an amendment that the word "regret" should be omitted, as he said the late Commission of Sewers had given the City of London Electric Lighting Company a monopoly of the supply for a certain number of years, and he doubted whether the Board of Trade would allow another company to compete in the City. While agreeing that the late Commission of Sewers had acted foolishly in giving that monopoly, he thought the Court should not express any regret in not complying with the application in question.—Mr. Gordon seconded the amendment.—Mr. Morton said it looked as if Mr. Hitching wished to drive the Corporation into the arms of the City of London Electric Light Company, and on their own terms. Competition in the City was badly needed so far as the electric light was concerned, and the City meant having it.—Mr. Deputy Sayer protested against what had been said concerning the monopoly which was granted to the City of London Electric Lighting Company. The Streets Committee did its best seven years ago, when the citizens were clamouring for the electric light, and nothing was done hurriedly. The public lighting cost only 2⅝d. per unit, which was, he thought, very reasonable.—Mr. H. H. Thompson said he thought it quite possible that the electric light would shortly be superseded by another illuminant. The amendment, on being voted upon, was rejected by a large majority, and the recommendation of the Committee was approved. We think, however, that the City Company should stir itself a little, and give greater attention to the interests of its consumers. The question of electric lighting competition is a debatable one, but what consumers want is a fair and reasonable supply, and the City Company should see that this is given.

Clontarf.—A special meeting of the Town Commissioners has been held to consider the question of the electric lighting of the township. It was unanimously decided to apply for a provisional order.

Cork.—On Tuesday last week the first instalment of the public electric lighting scheme was given when Bridge Street, portion of King Street, and the greater part of Patrick Street, was illuminated by a number of arc lamps. The display was to some extent experimental, but lamps are rapidly being put up all over the city and the quays.

Croydon.—Such is the rapid development in the electric lighting system of Croydon, that the Corporation are again approaching the Local Government Board for leave to borrow money for extension works. This time the application is for £3,100, of which £2,250 is for the purchase of part of the undertaking of the Crystal Palace Electric Lighting Company, and £850 for a sub-station at Norwood. A number of applications have been received by the Corporation for the extension of the mains in the Norwood district. A portion of Upper Norwood was originally included in the district supplied by the Crystal Palace Company. Now the Corporation of

Croydon have agreed provisionally (the agreement being subject to the Local Government Board sanctioning the loan) to take over that part of the company's undertaking, and to pay the amount spent on it by the company, with 33 per cent. extra. The exact amount spent on the works was £1,658 0s. 7d., and 33 per cent. on that amount is £547 3s., making a total of £2,205 3s. 7d. The Corporation propose to construct a transforming station at Norwood on freehold land, for which they have agreed to pay £800.

Dublin.—Last week there was a partial failure in the city supply.

Enfield.—The District Council is informing the North London Electricity Company that the Council has decided to itself apply for a provisional order.

Gillingham.—At the last meeting of the District Council a letter was read from Messrs. Geipel & Lange, consulting engineers to Mr. H. Jasper, asking that the Council should now make a fair payment for lighting the High Street with the electric lamps after the trial that had been given. The matter was sent to Committee.

Hampstead.—The Hampstead Vestry, who are going in for considerable extensions of their electric lighting installation, have borrowed £10,490 from the London County Council in order to obtain new plant and machinery.

Heckmondwike.—A suggestion has been made that the Dewsbury Corporation's mains should be carried forward to Heckmondwike. Certain proposals have been made to the Heckmondwike Council by the Dewsbury Gas, Electricity, and Water Committee, and these are now under consideration.

Hendon.—Two companies having submitted proposals to apply for provisional orders for the district, the Electric Lighting Committee does not advise that either scheme be accepted, but that the Council itself should apply for an order, and ask four stated experts for their terms for reporting on a scheme. Three areas are suggested for the experts to report upon.

Ilfracombe.—The Council is considering whether to transfer its electric lighting powers to a company.

Kensington.—At Wednesday's meeting of the Vestry a long discussion arose over the question of applying for a provisional order authorising the supply of electricity by the Vestry within the parish. The Electric Lighting Committee reported that negotiations were proceeding between the Vestry and the existing companies supplying the parish. They, however, advised that the Vestry should take the precautionary steps necessary to proceed with the application in the event of the negotiations falling through. The Vestry resolved to apply for an order.

Leamington.—Both the Corporation and the Midland Electric Light and Power Company are giving public notice of their intention to apply to the Board of Trade—the former for powers to enable them to erect stations and lay down mains and wires for the supplying of current, and the latter for confirmation of existing and grant of further powers. Similar applications were made last year.

Lewisham.—The Board of Trade has approved the stipulation of the Lewisham District Board of Works that no mains shall be laid under the footways except for service connections to houses. This applies to the scheme of the Crystal Palace and District Electric Lighting Company, who appealed to the Board of Trade on the point.

Llandrindod Wells.—The railway company have informed the Electric Light Committee that they have decided to have the station lit up by electricity. The work will be proceeded with at once.

London.—The County of London and Brush Provincial Electric Lighting Company, Limited, are advertising their intention to apply to the Board of Trade for a provisional order for the parishes of St. Mary, Stoke Newington, Hackney, and St. Matthew, Bethnal Green, and the districts of the Poplar and Whitechapel Board of Works. The St. Matthew, Bethnal Green Vestry are also announcing that they intend to apply for a provisional order for their district.

Lye.—The Urban District Council last week passed a resolution in favour of applying for a provisional order. The clerk reported that the British Electric Traction Company had abandoned their intention to apply for an order.

Marylebone.—At the last meeting of the Vestry, Mr. G. B. Crook came fully equipped with papers and books to fortify himself in proposing a motion of which he had given notice, but as the "house" was talked out Mr. Crook had to postpone his statement. The motion, which was to be considered at the meeting yesterday evening, proposes that the Electric Lighting Committee should be instructed (1) to inquire and report:—(*a*) What is comprised in the company's undertaking, so far as it is situated in as vendor, can make a good title to that part of its undertaking which is situated in or supplies with electricity the parish of St. Marylebone, including the benefit of any provisional orders and confirming Acts, and whether the Vestry can legally purchase; (*b*) What is comprised in the company's undertaking, so far as it is situated in or supplies, or was intended and is adapted to supply St. Marylebone, and whether what is specified or referred to in the report of the Committee is wholly separate (or capable of being wholly separated, and, generally, by what work and at what approximate expense) from that part of the company's undertaking, which is not situated in or used for supplying St. Marylebone. 2. If the company has power to sell and make a good title, to what is, or can at small expense be made, a wholly separate, independent and exclusive undertaking for the supply of St. Marylebone with electricity, then before report, to enter into a provisional contract with the company in the name, and on behalf, but subject to the approval of the Vestry, for the purchase of the benefit of such part of the company's provisional order, works, and undertaking, including a covenant not to compete with the Vestry, and not to use any part of its purchased or added plant (or to do so, subject to such limits, and on such terms as may be agreed), at a price to be hereafter agreed on, between the company and the Vestry, or in default of agreement, to be settled by submission of both parties to, and arbitration under, the Arbitration Act, 1889, or as may be otherwise agreed. 3. The Committee to be at liberty to employ such experts or obtain the benefit of such professional advice as they may consider necessary, for the purposes of this reference to the Committee.

It is a pity that Mr. Brooke-Hitching, when informing the members of Marylebone Vestry that the Electric Lighting Committee had learned from the very best source that the Board of Trade would not grant another provisional order to the Vestry, did not directly state what was implied by the best source. The not unnatural inference from this statement was that the Board of Trade had been approached unofficially by the committee, and that the Board also not officially had given a gentle intimation that a second application would be futile. It appears, however, from the Vestry's printed minutes that this view of the question is incorrect, and that Mr. Brooke-Hitching had based his assertion purely on the advice given by Mr. Manville. To say the least, it seems strange, considering the importance of the matter and the fact that the statement made by the chairman of the Electric Lighting Committee has been the means of committing the Vestry to the preliminary steps towards promoting a private Bill, that that gentleman omitted to mention that it was a consulting engineer and not the Board of Trade who had said that a second provisional order would not be granted.

Morecambe.—The District Council have decided to supply the electric light to the house of their electrician, Mr. Parkinson, free of cost. The West End Pier is forsaking gas for the electric light, and the mains will be laid ready for next season. It is proposed to extend the mains to the suburb of Bare, and the electrician is at present preparing an estimate of the cost.

Bills and accounts for £5,304 6s. 6d. were passed at the last meeting of the Council, the principal item being £4,000 on the contract of Messrs. Thomas Parker, Limited. The District Council have had a claim laid against them for £67 damages, alleged to have been caused to the property of Mr. J. R Birkett, by the men of the electrical department breaking holes through the foundation buttresses of property in Victoria Buildings.

Musselburgh.—The Town Council has decided to request Mr. Bryson, electrical engineer to Leith Town Council, to report on the whole question for electric supply for Musselburgh.

Northallerton.—The Urban Council is to grant permission to a company to erect overhead wires and supply the town with electric light. The company is to submit an agreement embodying terms, which are that the company has the privilege for a term of seven or 14 years. The company will work without a provisional order. Mr. J. E. Hutton appeared before the Council on behalf of the company last week.

Paisley.—It is stated that the municipality will commence running its electricity plant early in January.

Partick.—The sub-committee of the Glasgow Corporation Electricity Department has decided to continue the opposition to the application by the Kelvinside Electricity Company to the Board of Trade for a provisional order to supply Partick with electricity. A statement was made informally that the company were willing to dispose of their works and business to the Corporation, for which they still have 45 years to run, out of a monopoly granted for 50 years. Their estimate of the value of their system is £50,000, but the committee decided that any offer they could make would be limited to the capital expenditure and a goodwill of £5,000, making a total of about £30,000.

Ramsey (I.O.M.).—The Town Commissioners are asking the Isle of Man Electric Tramways Company and the Ramsey Gas Lighting Company to tender for the better lighting of the promenades.

Rawmarsh.—There is a proposal before the Council to appoint a committee to consider what shall be done to carry out the provisional order.

Rawtenstall.—Last week the Town Council decided to apply for a provisional order. A Committee was appointed to see the matter through.

Reading.—The Reading Electric Supply Company, Limited, is giving notice that it will apply to the Corporation for permission to alter the standard pressure from 100 volts to 200 volts.

Rhyl.—The District Council will hold a special meeting on 28th inst. to pass a resolution applying for a provisional order, also to instruct the surveyor to prepare, with the assistance of Mr. James Loftus, M.I.E.E., a map of area of supply and estimate of cost.

Rosario.—The municipality of Rosario is endeavouring to overthrow its public lighting contract with the River Plate Electric Light Company in order to favour a German concern. The case,

according to the *Public Health Engineer*, has gone to arbitration, but the municipality is resorting to every possible legal quibble discovered to defend its own trickery. The public, however, cannot be kept too well informed of the tactics which are resorted to in the endeavour to prejudice British capital.

Shoreditch.—The Board of Guardians have resolved to raise a loan (£2,000) for the installation of the electric light for their premises.

Southampton.—Mr. S. L. Smith, of London, has been appointed third assistant electrical engineer at the electricity works.

Stirling.—At last week's meeting of the Police Commissioners a letter was submitted from Prof. Kennedy pointing out that the mains had been extended considerably in accordance with the desire of the Committee, but as the work would be carried out at schedule prices the increase in price would be directly proportional to the increase in length. The Board of Trade has approved of the scheme.

Twickenham and Teddington.—The Twickenham and Teddington Electric Supply Company, Limited, have issued notice of intention to apply for an order to light these two parishes by electricity. They propose to complete the installation within two years from the date of the order.

Wednesbury.—The Town Council last Friday unanimously resolved that application be made to the Board of Trade for a provisional order.

Mr. Warden-Stevens has been appointed consulting engineer to the Corporation with regard to electricity supply.

Whitchurch.—A meeting of ratepayers has rejected the Urban Council's proposal to purchase the gasworks for £37,000. Some speakers said that electric lighting works could be established at less cost.

Wigan.—At a meeting of the Electric Lighting Committee on 18th inst., the chairman reported as to the visit of the deputation to Leeds, Bradford, and Wakefield, and it was decided that an installation be put down to supply Wigan with electric light, and that the Special Committee appointed by the Council be asked to prepare a report on their inquiries, and submit the same to this Committee.

Winchester.—It has been decided to light the Hants County Council offices at Winchester with electricity.

Woking.—The question of acquiring the Woking Electricity Supply Works is at present occupying the attention of the Woking Urban Council. The capital issued is £15,009. The first debenture issue represents £7,900, and the second £5,185. The number of shareholders is 15, Mr. Martin D. Rucker being the largest.

Worcester.—With reference to the appointment of electrical engineer, it is stated that the Electricity Committee have resolved that it is desirable that the names of three candidates should be submitted to the Council for selection for the office of electrical engineer, and two names were added to that of Mr. F. Harman Lewis. As we go to press we learn that Mr. Sutherland, of Hanley, has secured the appointment.

Yarmouth.—The Town Council having applied to the Port and Haven Commission for permission to cross the harbour with an overhead electric lighting main at a height of 162 feet for the purpose of carrying the electric light into Gorleston, the Commissioners have agreed to give the necessary permission, subject to the navigation not being impeded.

York.—It is hoped that by this time next year the electricity works will be in full swing.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Airdrie and Coatbridge.—When the New General Traction Company, Limited, Westminster, were negotiating with Airdrie and Coatbridge Town Councils to construct an electric tramway between these two towns for which they were going to apply to Parliament last session, the British Electric Traction Company stepped in and gave notice that they were going to apply to the Board of Trade for a light railway under the Light Railways Act. The Councils left the New General Traction Company alone, and supported the British Electric Traction Company in their application, which is now being considered by the Board of Trade. Now, the New General Traction Company, with a view to cutting out the other company in case their application fails, have given notice that they are going to apply to Parliament next session for an Act under the title of "Coatbridge and Airdrie Electric Tramways." Since the above was written our local representative informs us that the Board of Trade have refused the confirmation of the provisional order applied for by the British Electric Traction Company. After careful consideration of the evidence, they arrived at that decision by reason of the magnitude of the effect which the proposed undertaking would have on railways existing at the present time, namely, the Caledonian and North British Railways. The British Electric Traction Company have given notice that they are going to apply to Parliament next session for confirmation of the order granted by the Light Railway Commissioners. The New General Traction Company propose to extend the line to Clarkston, about half a mile further on in Airdrie than the British Electric Traction Company. The former company also mean to run a branch line along Sunnyside Road in Coatbridge, which the other company only will do when the main line pays.

Arbroath.—The Trades Council is asking the promoters of the proposed Dundee electric tramway scheme to extend the line to Arbroath.

Ayr.—At last week's Town Council meeting, a letter was read with reference to proposed electric tramways between Ayr and Prestwick. The total cost, including the electric motive power, was estimated at £44,460. The Council agreed to incorporate the scheme in their new Bill.

Bradford.—On 16th inst. the City Council decided to promote a local Act in Parliament for the construction of additional tramways and to secure various incidental powers. The chief proposals in the tramway extension scheme were those for a connection between Bridge Street and Morley Street, the construction of a tramway to Clayton—pursuant to an agreement come to with the Clayton District Council and the Queensbury District Council—and the construction of a tramway from Forster Square, along Kirkgate, Westgate, Whetley Hill, and Toller Lane.

Colchester.—An application is to be immediately made to the Light Railway Commissioners for an order to authorise the establishment of electric tramways (trolley) in Colchester. The Commissioners will in due course hold an inquiry into the subject. The promoters are the British Electric Traction Company, Limited.

Darwen.—Last week the Town Council held a special meeting to consider the promotion of a new Bill in Parliament, under which it is proposed to construct certain tramways to be worked, along with those to be taken over, by electricity. The Bill will give the Corporation power to work the tramways along with the Blackburn Corporation by means of a joint board. The Bill was approved, and on Wednesday it was to come before a town's meeting.

Dudley and Sedgley.—Further information has been disclosed with reference to the intentions of the British Electric Traction Company respecting the Dudley and Sedgley tramway, which they have just purchased and commenced to work. The company contemplate that about Christmas they will have at their service a sufficient number of engines in really good order, and will by that time have effected other necessary improvements, in order to enable them to keep up a continuous half-hourly service. Then the company propose to push forward the reconstruction of the present track for electrical traction. They hope to receive the co-operation of the Dudley, Sedgley, Coseley, and Wolverhampton authorities; and in that case it is anticipated there will be no difficulty in completing the line for an electrical service in about 12 months. It is asserted that by the successful carrying out of the company's scheme—in conjunction with three light railways the company have already powers to construct—there will be connected with a complete network of tramways the towns of Wolverhampton, Dudley, Sedgley, Coseley, Brierley Hill, Stourbridge, and the rural districts of Pensnett, Kingswinford, and Kinver. Another project of the company includes the welding of the tramways mentioned with their contemplated extensive system in South Staffordshire, thus providing direct access to Tipton, Wednesbury, and probably through Smethwick, into Birmingham.

Dundee.—The Tramways Committee has invited Prof. A. B. W. Kennedy to visit the town, with a view to advising it on the question of introducing electric tramways into Dundee. It is proposed that the necessary work shall be carried out by the city electrical engineer, Mr. Tittensor, under the advice and direction of Prof. Kennedy. The committee is to consider as to carrying out the agreement with the Tramway Company for taking over the buildings, plant, and machinery.

Farnborough.—The Council has been discussing the proposals of the Power and Traction, Limited, for working the present tramways as light electric railways, and to supply electricity for lighting purposes as well. The Council views the scheme with satisfaction.

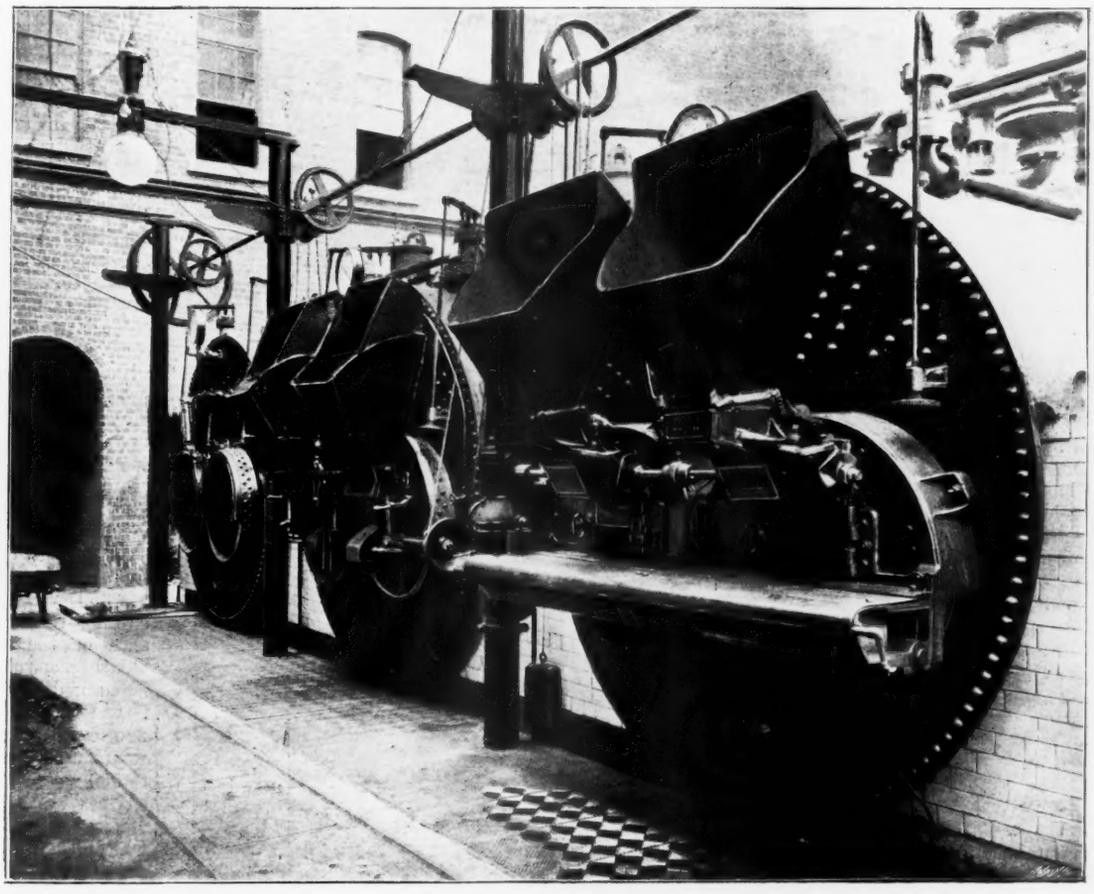
Hounslow and Twickenham.—The proposals of the Drake & Gorham Electric Traction Company to construct a light railway from Hounslow to Richmond, *vid* Twickenham, were discussed at the meeting of the Heston and Isleworth District Council on Tuesday, when Mr. Rowan, engineer to the promoters, attended to present the plans. In explaining them, he stated, replying to questions, that a light railway was sought in preference to a tramway, as the procedure for obtaining the order was easier. By the Act they could carry merchandise as well as passengers, but they did not wish to carry goods, as passenger traffic was what they had in view. They should use the overhead trolley system, with single standards, except in one road, where they should provide interlacing tracks. It was not necessary to widen any roads, but the company would have no objection to entertaining proposals to widen or construct streets. They had a 45-feet radius, but a 30-feet radius was quite feasible and common. They proposed granite paving between the metals, but would not object to Jarrah wood blocks. They would be prepared to deposit a sum of money as a guarantee that the order should be carried out. Their company was an established one, with orders to construct such lines in their possession. They were not speculating in these orders in order to form a company. The Council resolved formally to dissent from the proposals.

(*Continued on page* 792)

BELFAST ELECTRIC LIGHTING WORKS.

It is now more than three years since the gas-driven electrical works of the Belfast Corporation were opened; the demand for current has steadily outgrown the supply that could be met from these works, and it became necessary to embark on a more ambitious scheme. The position of affairs prior to the construction of the new works is set forth in a report which Mr. Victor McCowen presented some time ago to the Town Council:—

"Seeing that you have already expended about £33,000 in your present station and mains, and that all the available room for engines is taken up, and therefore the necessity of building another station, it is desirable that the system employed be such as will work in with the present one, and make use of your existing mains and plant to the best advantage. At present the distribution is on a three-wire continuous current system, at a pressure of 110 volts on each side, or a total of 220 volts. The distance of the farthest lamp from the station being 770 yards, or less than half a mile, for such an area of half-mile radius, I believe you could have employed no better system of distribution, viz., three-wire 220 volts; but when you desire to supply from one station an area of, say, two-mile radius, this pressure is too low to get economical results, on account of the excessive capital outlay on heavy feeders. The riverside site on the Lagan bank next the Albert Bridge is convenient for the delivery of coal, removal of ashes, and condensing water will be available, and is large enough to accommodate plant capable of supplying the city's requirements for a number of years. After taking into consideration the area you desire to supply, the provision of the site, and the present system of distribution, and the value of the mains already laid, I recommend that the three-wire continuous current system, with a pressure of 220 volts on each side, or a total of 440 volts, be adopted. This pressure will allow you to distribute current economically to a distance of about two miles from the station. A radius of two miles from the proposed site would include from Cliftonville on the north side to the Windsor district on the south side of the city. Consumers beyond this area could be supplied on a high pressure alternating system from the same station, or else from battery sub-stations, these sub-stations being placed at the end of the longest feeders, and the batteries charged at time of light load from the central station, and in this manner getting longer running hours out of the plant. It will be possible to change over the present station to work at double the voltage. These two stations would then deliver current into the same network of distributing mains, and help each other in dealing with the load. By the doubling of the present voltage, the value of the existing distributing mains will be considerably increased, as the capacity of them will be increased fourfold, and as these mains are laid in the parts of the city where there is a probability of a heavy lamp density, the increased capacity will be a distinct gain. The higher voltage will allow of better regulation and a smaller percentage variation of pressure at the

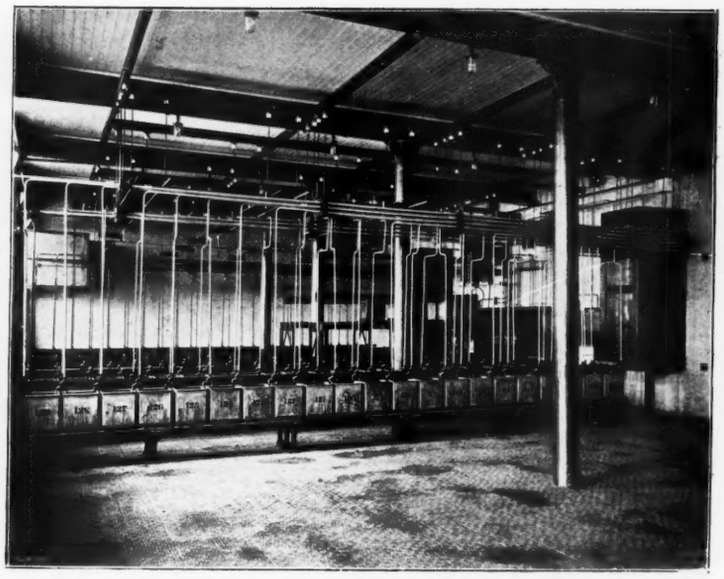


The Boiler House.

lamps. It may be well to mention that working at this pressure the dynamos would be made to generate current at a voltage which is approximately that required (and allowed by the Board of Trade) for electric traction —*i.e.*, 500 volts. So that should you desire at any time to supply current for this purpose, you can put in plant which can be used either for lighting or traction, without the necessity of introducing transforming apparatus for at least the greater part of the present tramway area. The supply of current to the extremities of the system could be arranged for by storage batteries charged from the central station at night, or by a high pressure transmission. By the combination of a steam-driven station and a gas-driven station supplying the same network of mains you should be able to get economical results. The steam station would take the bulk of the winter load, the gas-driven station helping over the peak of the load, and being always ready to take up a fog, or dark-day load. The gas-driven station would be able to do the summer load, when the steam station might be shut down for a few months (with the exception of a run off and on to charge the batteries, or arrangements could be made to charge these batteries in summer from the gas-driven station)."

In accordance with the recommendation of the electrical engineer, a steam-driven station has been erected on a site near the river Lagan, and the following are its chief features :—

The engine room is very spacious and lofty, being 200 feet × 40 feet. The works are situated within 150 yards of the river, thus giving ample water supply for condensing purposes; moreover, coal can be delivered by barge, the intention being at a future date to erect an overhead tramway between the riverside and the works, so that trucks of coal can be run in over the bunkers in the boiler room. The site is central for supplying to the different districts of the city, though up to the present mains have not been laid on the County Down side of the river. The new building, which is only a section of the entire scheme, occupies little over one-quarter of the space available, the total capacity of the site being about 20,000 horse-power.

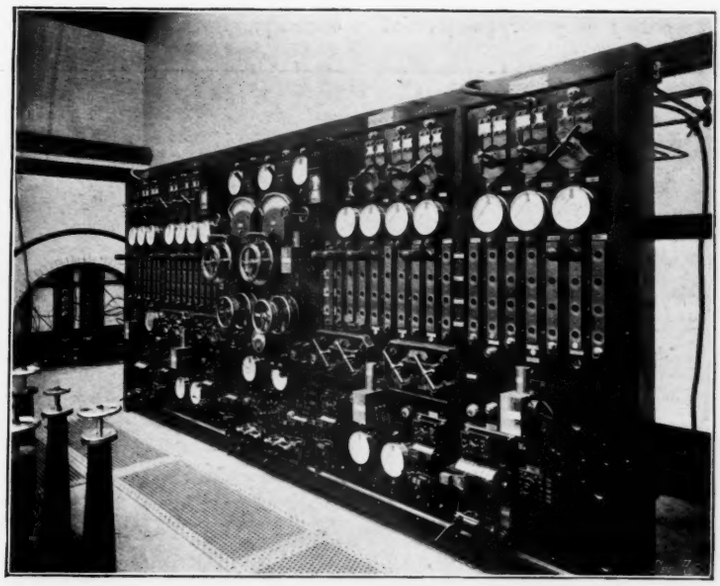


The Accumulator Room.

Resistances under Gallery.

In the engine house there are at present three sets of Belliss-Parker steam dynamos, two 100-kw., one 200-kw., and another 200-kw. in course of erection. The small sets consists of a two-crank compound engine, with a 50-kw. dynamo coupled to each end of the crankshaft, and when running at a speed of 380 revolutions per minute give their output at a voltage which may be varied from 220 to 350 volts by altering the resistance of the field. The higher voltage is required for battery charging. The 200-kw. sets are wound to give 440 to 500 volts. The engines are three-crank compound. One of these sets is arranged to be capable of doing traction work also, and is provided with an extra heavy fly-wheel and a compound winding. The Eickmeyer form of winding is employed on the dynamos. The regulating switches and resistances for these dynamos were also supplied by Messrs. Parker to Mr. McCowen's design. The resistance frames are placed under the switchboard gallery, and the sliding contact switch is worked from the gallery in front of the switchboard, by means of a hand wheel working a vertical rod

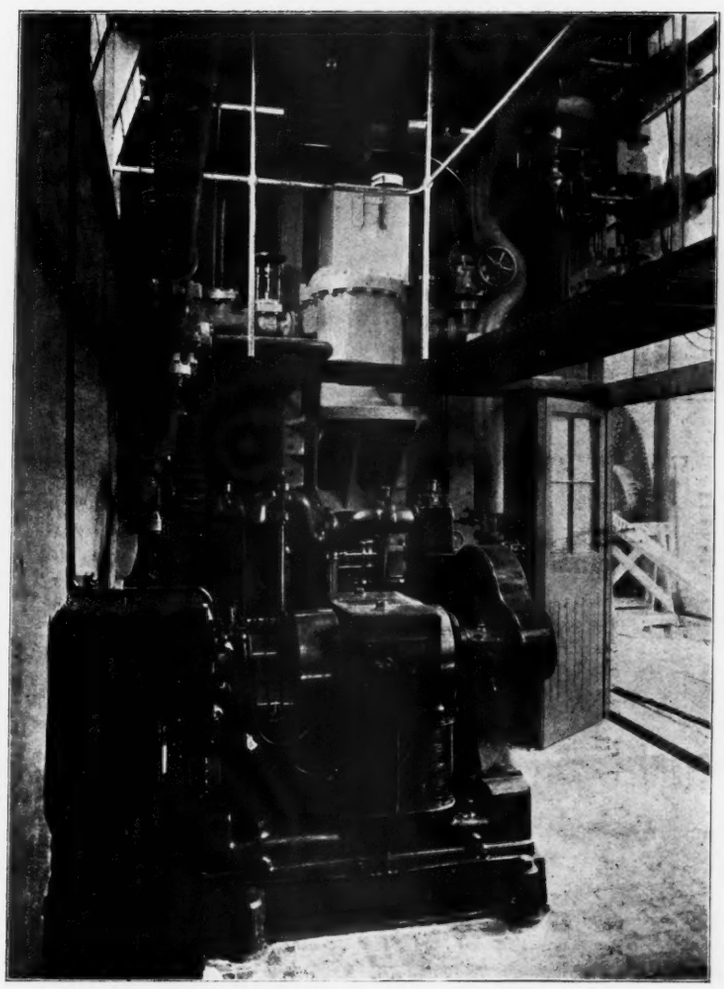
geared to a rack which actuates the switch. By this method the necessity of bringing the numerous resistance leads up to the switchboard is avoided, while the switch can be worked in full view of the switchboard. A balancing motor, generator, and pair of boosters are also erected in the engine house. They consist of four separate armatures, coupled in line, each armature having its own field magnet. The two inner machines are similar, each being wound to give 12 kw. at 220 to 250 volts, and are capable of dealing with an out-of-balance current of 100 amperes in the middle wire. The two outer machines are the boosters, each having an output of 100 amperes at any voltage between 0 and 120 by altering the resistance of the fields.



View of Switchboard.

All the armatures are drum-wound, and have their spindles provided with couplings to admit of changing and repairing the armatures. The bearings are of ample size, and self-lubricating, all parts being designed for long continuous running. The temperature rise after six hours at full load does not exceed 70° F. Each machine is separately excited at 220 to 250 volts.

The combined machines are started by a double motor starting switch placed with the necessary resistances beneath the switchboard platform, the switch being worked by hand wheel gearing from the platform level. On starting, each armature of the balancer is connected to the system through starting resistances, which are entirely cut out when full speed is reached, the double arrangement of switch being necessary as the fields of the balancer are cross-coupled to opposite sides of the three-wire system to minimise the regulation by hand. Shunt regulating gearing (worked also from the switchboard platform) is provided for the adjustment of the booster and balancer fields.



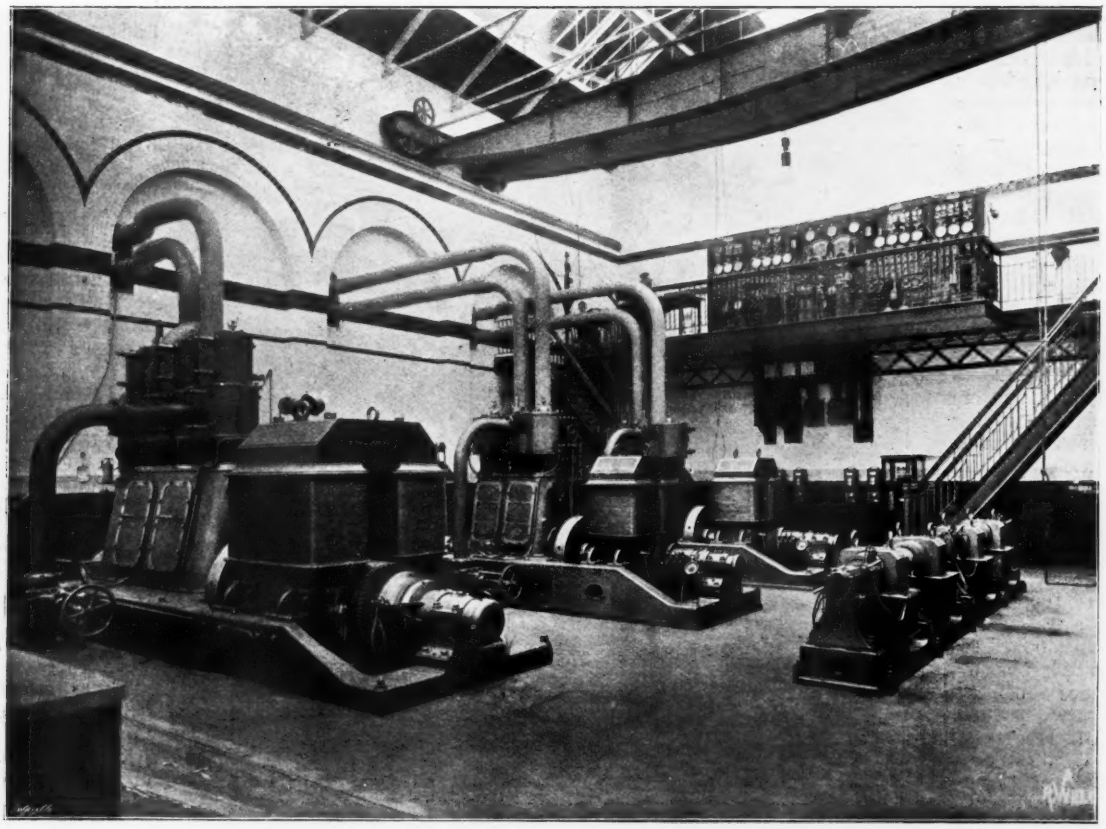
Electrically Driven Pump.

The boiler house is arranged to take 10 Lancashire boilers, 30 feet by 8 feet, four of which are at present erected and working at a pressure of 160 lbs. per square inch. They are constructed for a working pressure of 180 lbs. per square inch, and have been tested to 275 lbs. per square inch by hydraulic pressure. They are fitted with Hopkinson's mountings, made for a working pressure of 200 lbs. per square inch. One is arranged for hand firing, and the others are fitted with mechanical stokers of the "Sprinkler" type, provided with steam jet. The stokers are rope-geared to a countershaft fixed overhead and driven by an electric motor. A Green's economiser of 216 tubes is erected at the end of the house next the chimney, provision being made to increase this number to 864 tubes as required. The scrapers are driven by an electric motor. The coal bunkers extend the whole length of the range of boilers, and are provided with doors opening on to an elevated roadway from which carts can be unloaded with a minimum amount of labour. As already mentioned plant to convey the coal from the bunkers to the stoker hopper will be installed at a future date, and provision has been made for an overhead tramway from the riverside when the building is extended.

The feed-pump room is situated opposite the two centre boilers of the range, occupying a portion of the bunker

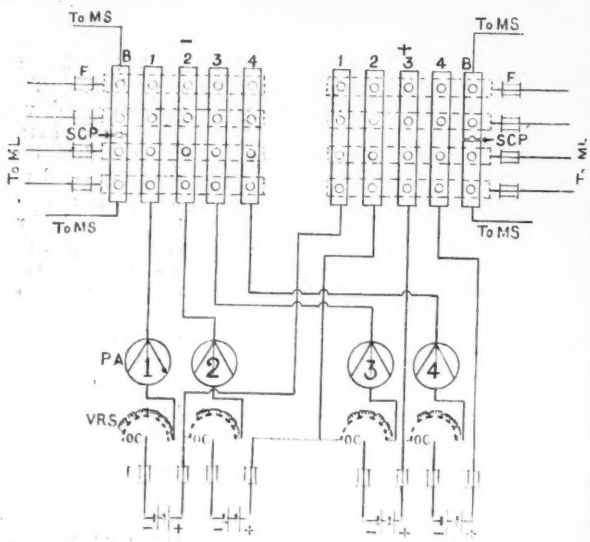
space. It contains two sets of horizontal duplex steam pumps, each capable of delivering to the boiler with and against 180 lbs. steam pressure, 4,000 gallons per hour (they are provided with duplicate steam supply); one three-throw electric pump, same duty as steam pumps, and

A complete duplicate system of steam pipes is provided between the engines and the boilers. The two main steam pipes are placed in the boiler house, being slung by rods from brackets fixed on the wall and from the roof irons. A branch pipe from each main connects to each engine through



General View of Engines and Dynamos.

provided with bye-pass and regulating resistance for varying the rate of feed: a feed water oil extracting filter and a Kennedy water meter, each capable of passing 10,000



To M S. To main switchboard; F, Fuses; To M L, To milking leads; S C P, Short circuiting plug; P A, Polarised ammeters; V R S, Variable resistance and switch; O C, Off charge.

Diagram of Connections of Hospital Cell Switchboard.

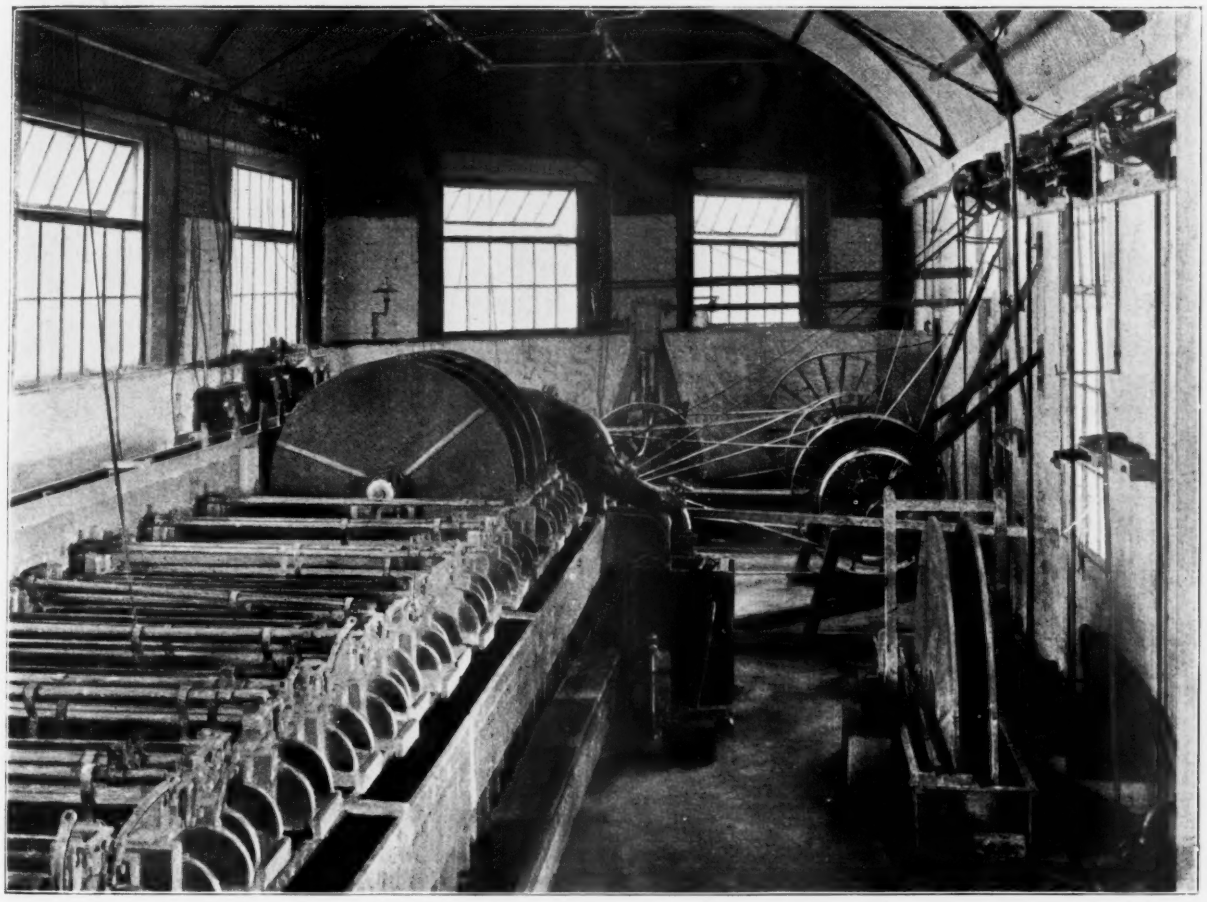
gallons of water per hour, the latter provided with a recording arrangement. A relief valve is fixed in each pump delivery and arranged to return all waste water to the feed tanks.

a Y-piece provided with valves, fixed on the steam receiver. The boilers have two junction valves with a 5-inch branch to each main. The main steam pipes are lap-welded mild steel, with wrought-steel flanges screwed and brazed on. Copper expansion bends connect the two ranges at the ends, and valves are fixed in suitable positions for dividing up the mains, one range only being in use at time of light load. The branch pipes to the engines and boilers are solid drawn copper, and the T-pieces cast-iron. The valves throughout are Hopkinson's patent parallel slide valves. Drains and steam traps are provided where necessary. The whole of the pipework was tested to 300 lbs. per square inch hydraulic when erected and jointed. The exhaust pipes are placed in trenches below the engine room floor level. The main pipe, which runs parallel to and next the division wall, is brought into the boiler house at one end, and through the roof, for use when the engines are running non-condensing. This is provided with a stop valve and a silencer. The main pipes are cast-iron, the branches to the engines being copper. A system of drain pipes is arranged for engine and boiler house, and deliver into tanks. The drains are 3-inch and the blow-off 4-inch cast-iron. The boilers are connected to the latter through isolating valves by copper bends.

A ring feed main is fixed round the pump room, to which is connected the deliveries from the pumps and economisers and the duplicate feeds to the boilers. The pipes are solid drawn copper throughout, and the necessary valves are Hopkinson's own make. Each pump is connected to two sets of tanks. The tanks are built below the stoking floor, and have a capacity of 20,000 gallons. There are also two distinct supplies from the city water mains.

The switchboard is placed on a platform 13 feet above the floor level at the west end of the engine room, and is arranged for six feeders, eight dynamos, a motor generator, the two "boosters," and battery regulators. There are at present erected five enamelled slate panels, 7 feet 6 inches

high, the width varying from 3 feet 3 inches to 2 feet 8 inches, according to the amount of apparatus mounted on each. The framework carrying them is built up of H section steel, the joints between the slates being covered with a teak moulding. The central panel carries the positive and negative battery and middle wire ammeters, battery emergency switches, and regulator hand-wheels and indicators, the feeder resistance switches, two large (Weston type) feeder voltmeters to show the pressure at the feeding points, three Kelvin electrostatic voltmeters for indicating the pressure between the middle wire and either side, and right across the system at the generating station end; the necessary apparatus and gear for two "boosters," including ammeters, automatic switches, shunt maker, and break switches and plug bars for connecting the boosters in the various ways they can be used. The other four panels carry the feeder and dynamo bars instruments, the two on the right of the centre panel being for the positive and the two on the left for the negative sides of the system. The feeder and dynamo bars are placed vertically on the front of the panels, the four bus bars being fixed horizontally at the back. The panels adjoining the centre one have, in addition to the above, a charge and discharge battery bar, which can be plugged on to any one of the bus bars, a safety arrangement being provided so that it is not possible to plug both charge and discharge on to the same bus bar together. A double-pole throw-over switch is provided in the circuit of each of the 50-kw. dynamos, so that they may be run in parallel on either sides of the system, or in series across the outers. A switch is also provided for disconnecting them from the middle wire. Each machine has in circuit with it an ammeter, a "minimum automatic cut-out," a fuse on both poles, and a supply meter. Each feeder has in circuit on both poles an ammeter, duplex fuse, and switch. The feeder resistance consist of five back E.M.F. cells on each side, which can be switched in between the top and second, or top and third bus bars, if it should be found necessary to slightly lower the pressure on a lightly-loaded feeder. These are actuated by hand-wheels fixed on the centre panel. The battery regulating switches, which are fixed in the battery room, are actuated from the switchboard through shaft and bevel gearing. Provision has also been made for working them direct in the battery room in the event of anything going wrong with the gear. A reversible ampere-hour meter is in the circuit of each battery. The shunt regulating resistance and switches of the dynamos, motor generators, and boosters, and the starting resistance and switch of the motor generator, are placed below the concrete floor of the switchboard platform, and are connected by suitable gear to hand-wheels supported on pedestals placed in a convenient position on the platform. The leads from the dynamos are brought through the foundation block in Doulton casings, and cleated up to the back of the wall supporting the switchboard platform. The feeders are brought from the switchboard in the form of insulated cables. These are cleated on to the end wall behind the switchboard, and taken through Doulton casings to the outside.



Cowper-Coles Electrolytic Cyclic Process.—Fig. 1.

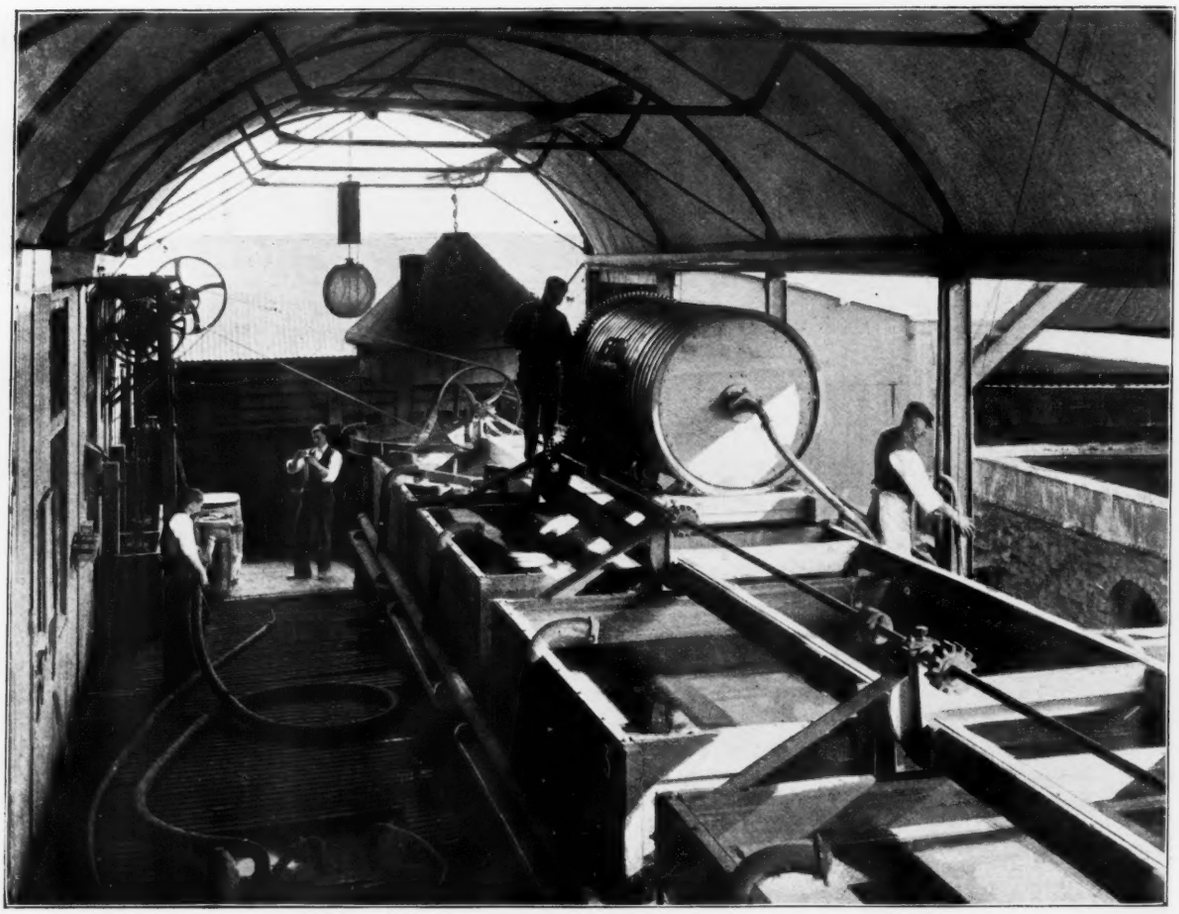
The battery room, adjoining the switchboard end of the engine room, is in a convenient position for working the battery regulating gear from the switchboard platform. Only about half of the available space is at present occupied by the two batteries, each consisting of 130 cells of the Faure-King type, having a capacity of 500 ampere-hours at a discharge rate of 100 amperes. They are also capable of discharging at 300 amperes for one hour. There are, in addition, eight hospital cells of the same capacity. The cells are placed in one tier at a convenient height on six parallel rows of stands, with a gangway between each pair of stands, and are suitably arranged for examination. There are 45 cells on each battery, connected by solid copper rods to the battery regulating switches, which are placed in enclosed cases in the battery room.

The system of distribution is the three-wire low tension, 440 volts between the outer wires, or 220 between

either outer and the middle wire, the latter being the pressure at which current is delivered to consumers, except in special cases, when a supply is given at 440 volts. The distributing mains are connected up in a network, and fed at several points by "feeders" from the generating stations. Pilot wires are connected from the feeding points to voltmeters on the station switchboard, so that the engineer in charge can see that the proper pressure is being maintained on the network. The mains consist of single-core cable, insulated with vulcanised bitumen and drawn into Doulton's earthenware casing when laid under footways, or into cast-iron pipes under roadways.

The Doulton conduits are of the standard type, with either two, three, or six rectangular ways, each $2\frac{1}{4}$ inches $\times$ $2\frac{1}{4}$ inches, and have been laid to the extent of about 250,000 feet of single duct. The joints between the lengths have been made by means of cast-iron clamp collars in two portions bolted together. The interior of the collars is recessed, and the upper piece is provided with an aperture, through which is poured rapidly setting bituminous compound. This entirely surrounds the ends of the lengths, and is prevented from entering the ducts by Doulton's patent expanding joint mandrels, one of which is inserted into each duct while the joint is being made. Perfect continuity of the ducts is thus secured, and the bolted collars provide ample strength at the joints. In the illustration given in our "Notes" columns are shown sections of the joint of three-way conduit before being filled in with bitumen. Branch cable connections are provided for in the following manner:—At suitable intervals in the line of conduits special lengths are laid, which are grooved during manufacture in such a way that, while strength is preserved, a longitudinal division can be made by means of a chisel when desired. When a T-connection is required, the upper portion of the split length is detached, giving access to the cables. The cable joints having been completed, a junction cover, made for the purpose, is substituted for the piece which has been detached. This cover is fitted with a cast-iron socket piece to take the service pipe. Details of the service box, as applied to a six-way conduit, are shown in our "Notes" columns.

Lead-covered and armoured three-core cable is also used in some of the avenues in the residential district. The most distant point supplied is about $2\frac{1}{4}$ miles from the generating station. There are at present an equivalent of 29,000 8-C.P. lamps connected to the mains, which include 150 H.P. in motors, and applications have been received for an equivalent of 8,000 8-C.P. lamps in addition, so that it will be necessary to order further plant at an early date. The "Wright" system of charging has been in operation since July 1st last, and when the advantages of this become known, the demand will no doubt increase still more rapidly.



Cowper Coles Electrolytic Cyclic Process.—Fig. 2.

COWPER-COLES ELECTROLYTIC CYCLIC PROCESS FOR THE TREATMENT OF REFRACTORY ORES.

On a former occasion we gave an introductory description of the Cowper-Coles process. We now give some further details and illustrations. One special feature of interest about the electro-deposition of the zinc from the sulphate solution is the throwing down of the zinc on to aluminium plates which can be either stationary or caused to revolve, as shown in fig. 1. The use of aluminium greatly facilitates the stripping of the zinc from the cathodes due to the formation of a loose film of oxide on the aluminium.

Hitherto the formation of zinc sponge has been nothing but a source of trouble and loss to those who have attempted to deposit zinc on a commercial scale, but Mr. Cowper-Coles has turned this difficulty to account. Zinc sponge

is deposited on revolving discs, such as shown in fig. 1, and is scraped off by means of adjustable wood scrapers and allowed to gravitate into a receiving box where it is drained. It is then dried, and forms a good substitute for what is commonly known as zinc dust, which is a greyish amorphous substance which is obtained as a sublimal product during the distillation of zinc from its ores.

This zinc dust is now largely used amongst other purposes in the Cowper-Coles regenerative electro-zincing process, to which we have also referred on former occasions. An analysis of zinc dust deposited by this method gave the following result :—

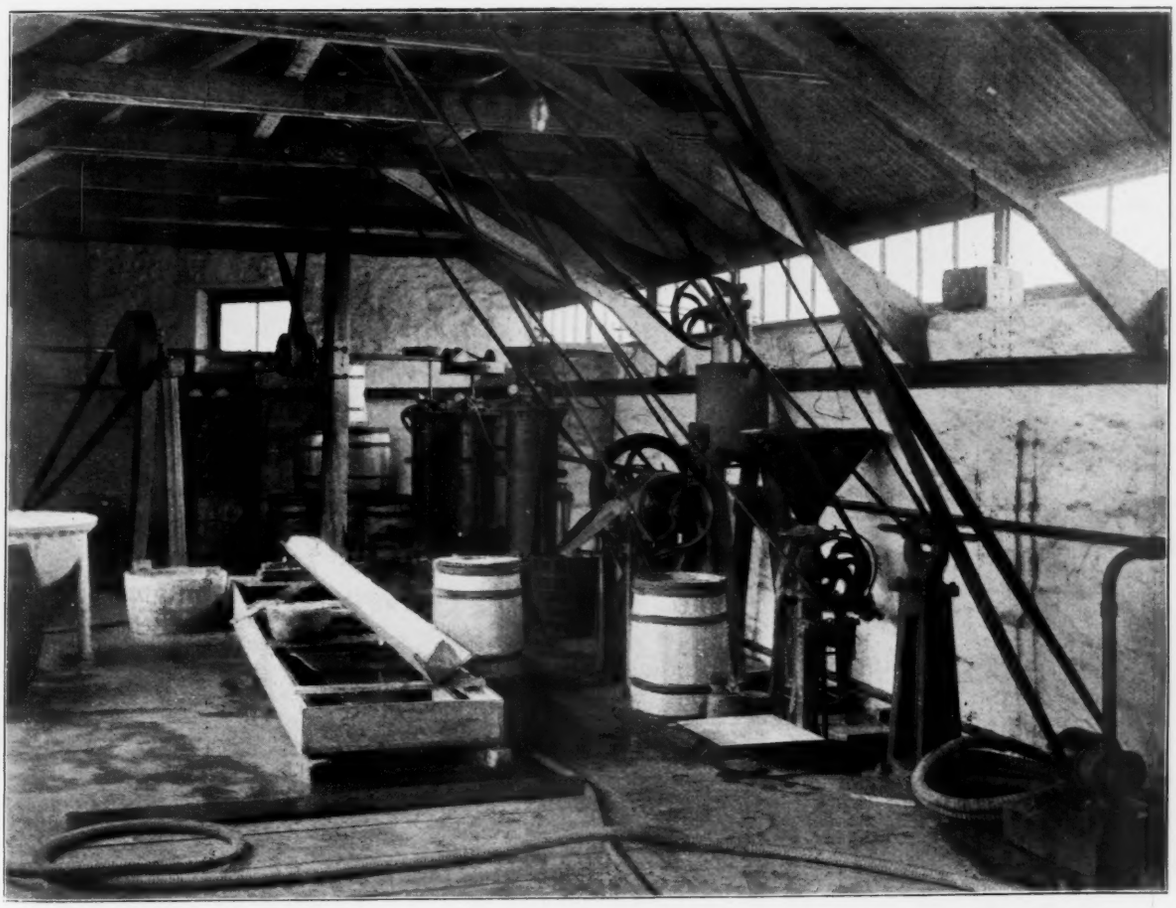
Metallic zinc	54·88 per cent.
Oxygen (in combination)	12·53 ,,
Sulphuric anhydride SO_3	10·05 ,,
Silica	1·05 ,,
Copper oxide	0·80 ,,
Lead oxide	0·07 ,,
Alumina	1·20 ,,
Ferric oxide	0·60 ,,
Lime	0·45 ,,
Chlorine and carbonic acid	traces
Moisture and organic matter	13·35 ,,
	100·00 per cent.

Antimony and Tin	0·0004 per cent.
Iron	0·0117 ,,
Nickel	trace
Zinc	0·0150 ,,
Lead by difference	99·6929 ,,

Fig. 2 gives a general view of the leaching vats which are each capable of treating from 1½ to 2 tons at a time. A revolving barrel is provided for treating the finer portions of the ore, and is arranged to run over the vats on rails so that the contents can be discharged into any of the leaching vats.

Fig. 3 shows the apparatus used for the production of white lead from the sodium plumbate solution obtained by leaching the ore with caustic soda.

This building is also furnished with the apparatus for the deposition of the silver after it has been leached out from the ore with a weak solution of cyanide of potassium. The silver is thrown down on to silver sheets and the whole melted down. The white lead is precipitated with carbon dioxide, which is produced from calcium carbonate by passing the sulphurous acid gas given off from the roasting furnace through water; the sulphurous acid solution is then used for driving off the CO_2 from the calcium carbonate.



Cowper-Coles Electrolytic Cyclic Process.—Fig. 3.

To ensure the zinc being deposited in the form of zinc sponge a low current density is employed in conjuction with a weak solution.

The lead obtained by leaching out with a solution of caustic soda is also deposited on revolving discs, and the deposit scraped off from time to time. It is found that the lead thus obtained can be readily melted down without the addition of any reducing agent. The lead is found to be very pure and a sample gave on analysis the following result :—

Copper	0·0800 per cent.
Cadmium	trace
Bismuth	trace

The CO_2 and sulphurous acid is drawn off and is then passed through a sodium plumbate solution so as to precipitate the lead as lead sulphite, and the CO_2 thus purified is then passed into another cylinder where lead carbonate is precipitated.

Litharge is also made from the sodium plumbate solution by evaporating it at a temperature not exceeding 80°C. The evaporating pan used for this purpose is shown on the left hand side of fig. 3, any sodium silicate that may be in solution having been previously precipitated as calcium silicate by the addition of calcium oxide.

We hope at a future date to give some more details of the process.

The St. Michel Chlorate Works, Savoy.—Generating Machinery.

The St. Michel Chlorate Works, Savoy.—Exterior View of Works.

THE ST. MICHEL ELECTROLYTIC CHLORATE WORKS.

By JOHN B. C. KERSHAW, F.I.C.

As a result of the progress in electrical engineering science during the past 15 years, the South Eastern Provinces of France, through which flow the tributaries of the Rhone, are becoming of great importance as manufacturing centres. Since 1890 a large number of important water-power developments have taken place in the valleys of the Arc and of the Isére, and over 10,000 H.P. is already furnished by the former river to the manufactories of chlorate of potash, aluminium, and calcium carbide, situated along its banks. The Arc rises near the Isére in Mont Iséran, Savoy, 9,236 feet above the sea level. After a most rapid course of 75 miles it rejoins the Isére at a height of 934 feet above the sea. The town of Modâne is situated on the Arc at a point 3,579 feet above sea level, and is connected with the railway system of the Rhone valley. Above Modâne the power of the Arc has been chiefly utilised for saw-mills, and the larger developments have occurred below that town, on account of the greater facilities for railway communication. Of these manufactories, the chlorate works at St. Michel, 6¾ miles below Modâne, is one of the most interesting.

This works is owned by the "Société d'Electrochimie," of Paris, and was built in 1894. Extensions to its present size were carried out in 1896. At this works between 3,000 and 4,000 H.P. is utilised in the manufacture of chlorates of potassium and sodium by the Gall and Montlaur process. The power utilised in the works is derived from the River Arc at a point in the Maurienne Valley, 1½ miles above the works. The torrent in this valley at the time of the melting of the winter snows upon Mont Iséran is most impetuous, and in the past enormous damage has been done to the villages situated along its course. This rush of water at certain seasons of the year has, of course, been taken into consideration in designing the larger hydraulic installations which are now found in the valley.

The water which operates the turbines at St. Michel Chlorate Works is conveyed from the intake by an underground channel, 1¼ miles in length, to a point 230 feet above the works. From this point, two pipe lines, 330 yards long and 47 inches in diameter, carry the water to the turbine house. The two pipe lines deliver 1,760 gallons water per second, and this volume serves to operate 12 × 200 H.P., and 4 × 400 H.P. turbines. Each turbine is keyed direct to a Thury dynamo, and is run at a speed of 300 revolutions per minute. The larger dynamos deliver 1,000 amperes at 200 volts, the smaller ones 500 amperes at 200 volts. The total electrical energy available for the manufacture is therefore = 2,000 kw.

The electrolytic process by which chlorate is made at this works, is in principle that described by Charles Watt in patent No. 13,755 of the year 1851. A solution of an alkali metal chloride is electrolysed between insoluble anodes, at a moderately high temperature, and the less soluble chlorate salt, formed by the reaction between the chlorine liberated at the anode and the caustic alkali formed at the cathode, is separated by crystallisation.

Chemically, the manufacture is explained by the following equations :—

$$6\,KCl = 6\,K + 6\,Cl. \qquad (1)$$
(K: Cathode. Cl: Anode.)

$$6\,K + 3\,H_2O = 6\,KOH + H. \qquad (2)$$

$$\begin{cases} 6\,KOH + 6\,Cl = 3\,KO\,Cl + 3\,KCl + 3\,H_2O. \\ 3\,KO\,Cl = KClO_3 + 2\,KCl. \end{cases} \qquad (3)$$

(1) Represents the electrolytic decomposition of the chloride salt; (2) the instantaneous reaction between the alkali metal and the water at the cathode; and (3) the two stages of the chemical reaction which occurs when chlorine and caustic alkali are brought together in a hot solution. Messrs. Gall and Montlaur's process is, therefore, essentially the same as that patented by Watt in 1851, and their English patent, No. 4,686, of 1887, chiefly refers to the apparatus used in carrying out the electrolysis. Rectangular vats lined with lead are used, each vat having a capacity of 11,000 gallons. The vats are insulated from the floor by oil cups. The anodes are of an alloy of platinum and iridium (90 per cent. platinum) which is found to stand the action of the chlorine better than pure platinum. They are only 1 mm. in thickness. The cathodes are of an iron-nickel alloy, and are covered with asbestos cloth in order to carry off the hydrogen liberated at their surface.

A very large volume of H (about 19,000 cubic feet) is produced for each ton of chlorate obtained, and this, carrying with it particles of the salt solution as it escapes, coats everything in the neighbourhood of the electrolysing vats with a crust of salt. In the process as originally carried out, diaphragms of special construction were used, and the caustic alkali formed in the cathode chamber was carried by external pipes to the anode chamber where the reaction with the chlorine occurred. These are, however, believed to have been discarded in favour of open vats; but upon this, as upon other important details of the process as now carried out at St. Michel, M. Gall, the Director of the "Société d'Electrochimie," is naturally not very communicative. MM. Gall and Montlaur were the first to successfully carry on the manufacture of chlorate of potash by the electrolytic method, and it is hardly to be expected that they will give away the results of their experience and skill in the conduct of their process.

A current density of 465 amperes is said to be used.*

In this way the solution in the vats is maintained at a temperature of 45° C., and no external heating is requisite in order to promote the conversion of the hypochlorite of potassium or sodium into chlorate. The electrolysed solution is run off from time to time, the chlorate is separated by crystallisation, and the electrolyte is brought up to its original strength by addition of fresh chloride.

When using potassium chloride as the starting points of the manufacture, the same electrolyte can be used for some weeks without complete renewal. The presence of metallic oxides in the vat solutions must be carefully avoided, since these instantaneously decompose KClO into KCl + O.

The chlorate obtained from the vat liquor requires recrystallisation before it is ready for the market.

The "Société d'Electrochimie," in addition to the works at St. Michel, possesses a chlorate factory at Vallorbes, in Switzerland, where 3,000 H.P. is utilised. The two works together are said to produce 1,800 tons chlorate per annum. The output per E.H.P. day at the commencement of the manufacture was only 1 kg. in place of the 2·69 kgs. demanded by theory, but M. Gall informs me that the yield has been materially increased since then. No details of the cost of manufacture at either Vallorbes or at St. Michel have been published, but the writer made an estimate last year,† according to which—with power at $\frac{1}{10}$d. per E.H.P.-hour, 1 lb. of chlorate could be produced by the electrolytic process for 2¾d. In the year 1891 chlorate of potash was selling for 5½d. per lb., and chlorate of soda for a slightly higher price, so that the manufacture of these chemicals must have given a very fair return upon the capital invested in it. Since that date, however, the competition between the producers by the older chemical method and by the electrolytic method has served to reduce the selling price to 3¾d. per lb., and the margin for profit is therefore correspondingly narrowed. The outlook for the future is also rather gloomy, since other electrolytic chlorate manufactories in Norway, Switzerland, and U.S.A., are entering the market with their products, and the keener competition between the manufacturers by the older process and the new electrolytic method is likely to still further depress prices. The "Société d'Electrochimie" is, however, well situated for producing chlorate cheaply at St. Michel and Vallorbes, and in a letter to the writer of this article dated June, 1897, M. Gall expresses himself as well satisfied with their ability to resist competition.

For the two excellent photographs of the St. Michel Factory used for illustrating this article, the writer's thanks are due to M. Gall. The first shows the intake of the pipe-lines 230 feet above the works, the pipe lines, and the factory, with the river Arc in the foreground. The second shows portion of the interior of the turbine and dynamo house.

* Patent No. 4,686, 1887.

† *Lightning*, June 17th, 1897, p. 505.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 782.)

Glasgow.—At a meeting of the Tramways Committee on the 15th inst. Mr. John Young, the manager, submitted a report for the previous fortnight on the working of the electric tramways between Mitchell Street and Springburn. It shows that the cost of the electric traction was 6½d. per car mile run, while the drawings were 1s. 4½d. per car mile, a profit of 10d. per car mile, 3d. more than by horse traction. It has to be noted that the departments are not yet getting the full use of the engine power. Mr. Young also submitted a report as to the probable cost of the conduit system of electric traction, as compared with that of the overhead system. He estimates that the introduction of the conduit system would cost £347,006 more than that for the overhead system for the 28 miles of tramways which have not yet been converted to electricity. With the exception of nine miles, which will not require to be relaid, these have all the old style of shallow rails. But even taking into consideration the cost of altering these, the adoption of electricity would result in a considerable saving as compared with the system of horse traction. It is estimated that to work traffic by means of the conduit system would cost about 5½d. per car mile, as against 5d. by the overhead system.

At last week's meeting of the Corporation Mr. Paton, in moving the approval of the minutes of the Tramway Committee, said it would have been noticed in the newspapers that reference had been made to the extension of the electric tramway to Govanhill. For the purpose of utilising the power house, the Committee had seriously entertained the idea of extending the trolley line to Govanhill. But a report had been sent to them from the Metropolitan Street Railway Company of New York, in which three months' experience of the working of the conduit system was referred to. The Committee had instructed the general manager to consider that report with reference to the Glasgow tramways, and to present a report within a reasonable time. Nothing will be done further in regard to the extension of the line until that report was received and probably brought before the Council. So far as the Springburn route was concerned, they were satisfied with the drawings on the one hand, for they had increased very much, while the working expenses were thoroughly satisfactory.

Ilkeston.—The Town Council are applying to the Board of Trade for two provisional orders authorising the provision of electric tramways and the supply of electricity in the borough. The estimated cost is £80,000.

Liverpool.—The Tramways Committee last week considered Major Cardew's report on the Dingle electric tram system. The committee resolved that the electrical engineer and the city engineer be instructed to carry out the recommendations contained in Major Cardew's report, and that they be authorised to provide foot sand boxes for the German motor cars, and air brakes for the American cars, and to order the same from the respective contractors for the cars; also that the manager make arrangements for stopping places in accordance with the report.

Manchester.—As mentioned last week, the City Council on 16th inst. considered the report of the Special Committee on the subject of tramways. Alderman Higginbottom, who moved the adoption of the report, entered into a strong defence of the recommendation of the Committee, which had been adopted by the Council, that the overhead trolley system should be adopted in preference to the conduit system. He estimated that within a very few years of the tramcars beginning to run electrically there would be a net annual profit of £70,000 in aid of the rates. Referring to the capital cost of the trolley and the conduit systems respectively, he said he would eliminate from the cost of both systems the items which were common to both systems, viz., feeder mains underground, the generating plant at the central stations, the transforming plant and buildings in various parts of the city, electric cars, and the depôts. The result would be approximately as follows upon the basis of the single and double tracks within the city:—The cost of bonding the present rails would be £135 per mile of single track, the overhead wire posts and cross span wires varied for double track from £1,200 to £2,400 per mile, and for single track £1,000 to £2,000, or take it at the highest figure of £2,000 per mile of single track. That made a total of £2,135 per mile single track, which, multiplied by 67 miles, gave £143,045, or, say, £144,000 in round figures. They must bear in mind that one great item of capital in this overhead system in Manchester was not required owing to the tram rails and roadway being at present suitable for electric traction. The conduit system embraced new rails, excavation, fixing culverts, fixing yokes, electric rails in culverts, taking up the roadway, and relaying with part old setts and part new. That was estimated per mile of single track by Mr. Pearson to be £11,078, and by Mr. Philip Dawson £11,396, while the Committee's Tramway Report gave the double track at £17,331, or, say, a single track £12,000. These figures give an average cost of £11,491. Multiply that by 67 miles in the city, and they had £773,897, as against £144,000 by the overhead trolley system. They must, however, bear in mind that the capital cost as given was quite apart from the capital cost to be incurred for generating plant, mains underground, electric cars, of which about 500 would be be required, car depôts, &c. When the question of municipalisation of the tramways was before the Council, and when the Tramways Committee report was adopted and municipalisation was decided upon, he pointed out that the whole capital cost of the undertaking would be, roughly, £600,000 on the overhead trolley system. If, therefore, the "overhead" system was discarded and the "conduit" system adopted for the whole city, the difference between the £144,000 and the £773,897, viz, £629,897 would have to be added to the orignal item of £600,000, making a total of £1,229,897 for the whole undertaking within the city. Mr. Boyle seconded the resolution, and after a brief discussion it was unanimously adopted.

A deputation from the Corporation visited Liverpool on Tuesday and inspected the new electric trams, and inspected the system at work in Liverpool. They also visited the works of Messrs. George F. Milnes & Co., Limited, Birkenhead, and inspected various kinds of electric trams in the course of construction for the Corporations of Plymouth, Blackburn, Halifax, Sheffield, Hull, and other towns.

The Metropolitan Railway and Electric Traction.—We learn from Monday's *Times* that contracts for the experimental electrical work on the Metropolitan Railway between Earl's Court and High Street, Kensington, have been let, and will be executed forthwith under the direction of Sir J. Wolfe Barry and Mr. W. H. Preece, C.B. It is proposed to lay down between Earl's Court and High Street, Kensington, an installation adequate for the haulage of a train which shall be fully as heavy as those now running at the busiest times of the day on the Metropolitan Railway. This section of the company's line has been chosen for two special reasons—first, because the ordinary service thereon is not so frequent as that on other sections; and, in the second place, because it contains some steep gradients—as sharp as 1 in 40—which will enable the new electrical system to be tested under the severest conditions that would be experienced in regular working. Each company has agreed to put down the sum of £10,000 to defray the cost of the experiments, and these will be carried on, without any interruption of the present steam locomotive traffic, for 8 or 10 months—a period sufficiently long to demonstrate the practicability of the principle thereafter to be introduced generally on the lines of the Metropolitan and the Metropolitan District Railways. In the first instance the generating station, erected on land belonging to the Metropolitan District Railway Company at Earl's Court will, in all respects save foundations for boilers and dynamos, be temporary in character. Two conductors are to be laid parallel between each of the lines of the permanent way between Earl's Court and High Street, Kensington, and these will be permanently available when the electric system is introduced generally on the two railways. The contractors have been instructed to build, for the purposes of the experiments, two motors, so designed as to form part of the permanent plant, and the train used will be similar to those now running over the Inner Circle. It is expected that the preparations for this important trial will be completed during the summer of next year.

Oldham.—On Saturday evening Sir Bosdin T. Leach, of Manchester, delivered an interesting lecture on "The History and Development of Tramways" in the Free Library Lecture Hall, Oldham. He recommended the Oldham Corporation, who were taking over the tramways in the town, to adopt the overhead trolley system of traction. Alderman Eckersley, chairman of the Surveyors and Tramways Committee of the Oldham Corporation, presided.

Perth.—The Perth and District Tramway Company have made application to the Police Commissioners for their consent to convert the tramways from horse to electric traction.

Portugal.—After long negotiations, a concession has been granted for the establishment and working of a system of electric tramways in Lisbon.

Portsmouth.—The Town Council on Tuesday decided to give 12 months' notice to the Provincial Tramways Company of their intention to purchase the local tramways, the question of price to be settled by arbitration. Electricity will then be used, and a deputation is to be sent to various towns in England and the Continent to obtain information. The estimated cost of purchase and equipment is about £245,000.

Reading.—The Town Council has appointed a Tramways Committee to look after the borough tramway business, including the purchase of the tramways company's system.

Rheims.—The horse tramways here are to be converted to electric traction. *Sell's Commercial Intelligence* suggests that it may be worth the while of British electrical contractors to try to secure the business. The tramway company is a Belgian one, and the address is La Compagnie de Tramways de Rheims, Sharbeck, Brussels, Belgium.

Spain.—The new electric tramways in Barcelona are so far completed that a trial run was made on the 9th inst. The line will, however, not be opened to the public until January 1st next.

A proposal for the construction of an underground electric railway in Madrid has just been submitted to the Spanish Minister of Public Works. The line would be a double-track one, about 3½ kilometres long.

Spen Valley.—The usual notice is being given of the intention of the British Electric Traction Company to apply this month to the Light Railway Commissioners for an order authorising light railways in the West Riding of the county of York, in the parishes and boroughs of Dewsbury and Batley, and in the parishes and urban districts of Ravensthorpe, Heckmondwike, Liversedge, Gomersall, and Cleckheaton.

Stretford.—The Council resolved to give notice to the Manchester Carriage and Tramway Company requiring them to sell the tramways to the Council. A resolution that negotiations be entered into with the Carriage Company to continue the working of the tramways until the lease expires in 1901 will have further consideration.

Teddington.—The District Council of Teddington last week received intimation that the London United Tramways Company, Limited, would apply for an order to construct a light railway, with electric traction, in the district. The question was adjourned pending receipt of their plans, but several members expressed the idea that the company might combine electric lighting with their scheme.

Wallasey.—By 14 votes to 6 the District Council have approved a scheme to borrow £284,000 for electric tramways and other improvements. A poll, however, is to be taken.

Wheatley.—The British Electric Traction Company has informed the Parish Council that they intend applying to the Light Railway Commissioners for an order authorising the construction and working of light railways in the Wheatley district.

Wood Green - Strand Underground Electric.—The Parliamentary notice of a Bill to be presented for an electric standard gauge railway from the Great Northern Station at Wood Green to a point in the Strand close to the Law Courts shows that for part of the way the proposed line will run under the new street from Holborn to the Strand, with stations at Euston Road, Holborn, and elsewhere. Great Northern suburban traffic will be hauled over the underground line, as is proposed to be done in the case of the Great Northern and City.

Yarmouth.—At a special statutory meeting of the Great Yarmouth Town Council on Tuesday it was decided by 31 against 2 to proceed at once to promote a Bill empowering the Corporation to construct and work electric tramways and improve certain streets in connection with the undertaking. The cost of the scheme is estimated at £53,000.

TELEGRAPH AND TELEPHONE NOTES.

The Berber-Suakin Telegraph.—A Reuter's despatch, dated Cairo, 23rd inst., says that the Berber-Suakin telegraph having been completed, telegraphic communication is now open between Cairo and Suakin and Kassala over the Egyptian and Suakin military lines.

The City and the Telephone Service.—The Court of Common Council last week agreed that application should be made for a license to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area.

Glasgow Telephones.—A representative of the *Glasgow Evening Times* saw Mr. W. E. L. Gaine, general manager of the National Telephone Company, with reference to the Glasgow telephone question. He said that the company had felt for a long time that a great deal of energy, time, and money had been and was being expended by themselves and the Corporation of Glasgow, and that they ought to put their heads together to consider whether some arrangements were not practicable which would meet the views of the Corporation and the interests of the public. The Corporation had been very persistent for some years past in its endeavours to get from Government the right to come in and offer a competing service to that of the company. Rightly or wrongly, the Telephone Company held the view that this was an Imperial service and not a local service, and that it was just as right that the Corporation should undertake a local telegraph or a postal service as a local telephone service. They thought also that the underlying principle which determined whether the municipality should undertake a public service was (1) that it ought to be a service which was of general benefit to the community; and (2) that it ought not to be in opposition to any existing undertaking. Mr. Gaine went on to say that since the Parliamentary Committee had issued its report, the Postmaster-General had intimated that he was willing to grant the Corporation a license, provided they obtained Parliamentary powers to work it. The company felt that its duty was to place itself in communication with the Corporation, and to endeavour, if practicable, to come to some reasonable understanding. They had accordingly made certain proposals to the Corporation, to which they awaited a reply. In the view of the company, the Parliamentary fight, which was apparently imminent, ought, in the interests of all parties, to be avoided if possible. The position of the company was that it would be compelled to fight any application of the Corporation to the utmost. He did not say this in way of a threat, but the action of the Corporation was a vital attack upon the company, which, for the protection of its shareholders, it was bound to resist. In his opinion, this Parliamentary fight would cost the parties not much less than £15,000, which would be much better spent in the development and improvement of the service. In making its proposal, it seemed to the company that there were three things for which the Corporation had been contending: (1) To obtain a cheaper price for small users; (2) to obtain greater efficiency by the substitution of the twin-wire for the present single-wire system; and (3) to obtain an improvement in local administration. Mr. Gaine explained that they had proposed to the Corporation an entirely new scale of charges, which was designed to meet the wants of small users, especially of tradespeople who felt the need of a service, but who did not themselves desire to initiate many conversations. It was proposed to take on all subscribers at a minimum tariff of £6 per annum, which would give the subscriber the right to call up 500 times every year, and to be called up by other subscribers as often as they thought fit without charge. The company also offered to make arrangements with anyone to put up a call sign so that if the subscribers did not need to call up as many as 500 times in the year and the outside public came in to use his instrument the charge to him would be less than £6. Another very important feature of the proposal in the scale of charges was the party line system for private house. This system had not hitherto been tried in Europe, but it has been adopted with marked success in America, and the company considered it would be an interesting experiment. The strong and persistent efforts of the Corporation had compelled the company to consider very carefully both weak points in its armour and the strength of the claims put forward by the Corporation on behalf of the public. The company recognised that possibly there was a weak place in its local administration. Since the inquiry in Glasgow they had called to Glasgow as district manager one of the most capable men it had in its service, and with the view of keeping the board of the company thoroughly in touch with local requirements they proposed to the Corporation to appoint a local committee with four members—two to be appointed by the company and two by the Corporation—the object of the company being that the views of the Corporation and the requirements of the public service might be brought clearly and constantly to the attention of the board.

Hampstead and the Telephone Company.—At the last meeting of the Hampstead Vestry, Sir Henry Harben presiding, a deputation, consisting of Mr. Clay, the Metropolitan superintendent of the National Telephone Company, Limited, and residents of the parish requiring telephone communication, attended, and urged the Vestry to grant the company permission to lay underground wires in Hampstead. The matter has been in dispute for some time, and the general feeling of the Vestry is that something considerably more than the peppercorn rent offered by the company must be paid to the ratepayers as wayleave. After Mr. Clay had been submitted to a severe heckling, the question was referred to the General Purposes Committee of the Vestry for further consideration and report.

Manchester Telephones.—The City Council Telephone Committee will prepare a report setting forth its recent communications with the Postmaster-General, and embodying the general conclusion that, in view of the proposed action of H.M. Government in this matter in the next Parliamentary session, it is desirable not to proceed further with respect to the insertion of clauses in the General Powers Bill for working telephones under a Post Office license.

The Pacific Cable.—In reply to a deputation from the Sydney Chamber of Commerce, which waited upon the Hon. the Postmaster-General at Sydney, recently, to urge upon him once more the necessity for the establishment of a cable *vid* the Pacific, passing through British territory, and under Government control, Mr. Parkes said the question of cable communication had not escaped his notice. Recent developments, since the Chamber had waited on his predecessor, Mr. Cook, had put things in a different light. About a month ago the Government sent a cable to the Imperial Government, asking if they would agree to bear a one-third portion of the subsidy of the Pacific cable, but no reply had yet been received; therefore it was impossible for him to act. The British Government have an apparent disinclination to subsidise the Pacific cable at all. They lean entirely to the Eastern Extension Company's cable proposal. An Admiralty Commission met in July last to discuss this route, and also took into consideration the other. That Commission strongly recommended that the British Government should subsidise the route known as the Cape of Good Hope one, because they would have absolute control of it. The Commission pointed out that the Pacific cable would be difficult to maintain, and that the Government would not have control over the waters through which it passed. The Commission had raised such strong objections that the Agent-General had advised that he thought it impossible to break them down. If at any time the Pacific cable, when constructed, collapsed, the colonies would be at the mercy of the Eastern Extension Company, whereas probably the other proposed line would be a double one, and all the colonies would be joined in it. If the two services were working against one another, and could bring in a national line to compete, a very cheap service would then be obtained. The financial question was the difficulty which at present obtruded itself. There was, however, a very ready method of securing a Pacific cable, though not an all-British one. This was to run a line from Queensland to join the American cable that was being laid to Honolulu. This might be an alternative proposal. Whatever route was decided upon, he could promise that the public interests should not suffer.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies—		
St. Lucia-St. Vincent ...	Sept. 24th, 1898 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Pernambucc-Ceara	Oct. 19th, 1898 ...	Nov. 22nd, 1898.
Saint Louis-Novonha ...	Oct. 17th, 1898 ...	...
Para-Maranham	Nov. 15th, 1898 ...	...
Landlines.		
Majunga-Tananarive	Nov. 16th, 1898 ...	Nov. 17th, 1898.
	Nov. 22nd, 1898 ...	...

The Telephone Question.—The following letter, published in the *Times*, advocating the nationalisation of telephones, is understood to express the views of the Council of Associated Stock Exchanges:—

"Liverpool, *November 14th.*

"Sir,—I venture to ask for your advocacy in a matter of very great moment to the business interests, at least, of the country.

"I think it is clear that the attitude adopted by the Post Office towards the National Telephone Company will have one effect—that is to say, the prohibition of that development on the part of the company which ought to meet the growing and imperative demands for its services. It is scarcely possible to expect a threatened company to embark fresh capital in order to meet such requirements. On the other hand, any attempt at a Government local service in competition with the National Company might easily result in a disastrous loss to the Post Office.

"It is doubtful if the country will patiently submit to an inadequate service, and I think they would welcome a reasonable settlement with the National Telephone Company. I cannot see why the matter should be incapable of arrangement upon terms both fair to the company and highly advantageous to the Post Office.

"Assuming a Government purchase based upon the average market prices, high and low, of the company's stock and shares, during the past three years, taking into consideration the reduced interest charges and economy of working, and crediting the business with nothing beyond its normal progressive development, the result, so far as I can estimate it, would be that the surplus profits and royalties, if placed to a cumulative sinking fund, would at the expiry of the license (13 years hence) practically suffice to extinguish the purchase-money. Surely this would satisfy the most prudent Chancellor of the Exchequer. The adoption by the Government of the National Company's system and its prompt development under the guidance and co-operation of the company's present administration offer, in my judgment, the only assurance of a widespread and perfect system of telephones for the present generation of business men.—I am, Sir, your obedient servant, Edward Rae."

CONTRACTS OPEN AND CLOSED.

OPEN.

Barnsley.—December 12th. The Corporation is inviting tenders for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of electricity supply works, and engine, &c, foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and service boxes, and service connections. Specifications and all particulars can be obtained on application to Mr. Thos. L. Miller, M.I.E.E., 7, Tower Buildings, N., Water Street, Liverpool, on payment of £1 1s. for each section, returnable as usual.

Beckenham.—December 17th. The Urban District Council invites tenders for water-tube boilers, alternators, transformers, pipe work, feed pumps, arc lamps and posts, cables and other street works, travelling crane, &c., &c., for the electric lighting scheme. Specifications, &c., from Messrs. Wilson & Story, 66, Victoria Street. See our "Official Notices" November 18th.

Blackpool.—Corporation wants tenders for trolleys, wire, &c., in connection with conversion of conduit lines. See our "Official Notices" November 11th.

Dublin.—December 5th. The Dublin United Tramways Company is prepared to receive tenders for the supply of general stores, including car fittings, iron, steel castings, oils, electrical supplies, &c., &c., for the year ending December 31st, 1899. Information can be obtained, and patterns seen, at the company's offices, 9, Upper Sackville Street, Dublin, from November 15th to December 2nd. Forms of tender 1s. each.

Dublin.—December 5th. The Board of Control want estimates for engines, dynamos, and wiring for about 100 electrical H.P. at Richmond District Lunatic Asylum. See our "Official Notices" November 18th for particulars.

France.—November 28th. Tenders are being invited until the 28th inst., by the municipal authorities of Anzin (Nord), for the concession for the lighting of the town during a period of 40 years, either by gas or electricity. Tenders to be sent to La Mairie d'Anzin (Nord), whence particulars may be obtained.

France.—December 6th. Tenders are being invited by the French Post and Telegraph authorities in Paris for the supply of 100 tons of galvanised iron wire 8 mm. diameter, 30 tons of galvanised iron wire 5 mm. diameter, and 80 kilometres of submarine cable core. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris, whence particulars may be obtained.

Halifax.—The Corporation wants tenders for meters, transformers, and arc lamps. See our "Official Notices" November 18th.

Middlesbrough.—November 29th. The Electric Lighting Committee is inviting tenders for the supply and erection of Lancashire boilers, and boiler house plant, slow speed steam dynamos and accessories, condensing plant and pipe work, overhead travelling crane, switchboard and instruments, accumulators, supply and laying of cables, meters. Specifications, &c, from the consulting engineer, Mr. Robert Hammond, 64, Victoria Street. See our "Official Notices" October 28th for further particulars.

Salford.—December 15th. The Electric Lighting Committee want tenders for the supply and erection of the following plant for the Electric Light Committee. Section (1) boilers; (2) engines; (3) dynamos; (4) boiler feed pumps, &c.; (5) mechanical stokers; (6) superheaters; (7) economisers; (8) condensers, &c.; (9) steam and water pipes; (10) cranes and weighing machines; (11) tanks, &c.; (12) switchboards; (13) booster. Specification, information, &c., may be obtained from the electrical engineer, Walness Road, Broughton, on payment of £5, returnable as usual.

Shanghai.—The Shanghai Municipal Council invites tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook & Co., 8, Jeffreys Square, St. Mary Axe, London, E.C.

Shanghai.—The Shanghai Municipal Council invites tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook & Co., 8, Jeffreys Square, St. Mary Axe, London, E.C. See our "Official Notices" November 18th.

Shoreditch.—December 13th. The Vestry want tenders for six direct-current rotary transformers. See our "Official Notices" this week.

Tanfield (Durham).—November 29th. The Urban District Council are, according to an exchange, inviting tenders for various electrical plant throughout their district, including engines, dynamos, cables, insulators, poles, &c. Information may be obtained by appointment to Mr. Robert Heslop, surveyor, Burnopfield, R.S.O. Tenders to be sent to the surveyor by Tuesday next.

Waterloo-with-Seaforth (Lancs.).—November 26th. The Urban District Council invite tenders for the supply of 16 electric arc lamp columns and carriers. Specifications and further particulars obtained from Mr. F. Spencer Yates, A.M.Inst.C.E., surveyor to the Council, at the Town Hall.

CLOSED.

Bury (Lancs.)—A large number of local and other firms tendered for the electric wiring of the public baths for the Corporation, and the contract has been given to Messrs. Calvert and Co., of Manchester.

France.—The French Post and Telegraph authorities in Paris have just placed a contract, as follows, for 60 kilometres of paper insulated electric cable with the Société Alsacienne de Constructions Mécaniques, of Belfort, at £11,320.

Roumania.—An English firm—Messrs. Ramsden Camm, of Brighouse—has just succeeded in submitting the lowest tender for the supply of 60 tons of steel wire 2 mm. diameter to the Roumanian Post and Telegraph authorities in Bucharest, quoting 569½ francs per ton delivered.

Watford.—Mr. W. C. C. Hawtayne in a report to the District Council, which has since been adopted, recommended that the tender of the Reason Manufacturing Company for cut-outs be accepted. Of the four meters for which prices were obtained the three cheapest quotations were those of the General Electric Company, the British Thomson-Houston Company, and Venner & Co. The tender of Messrs. Venner & Co. has been accepted.

FORTHCOMING EVENTS.

Friday, November 25th.—At 5 p.m. Physical Society. Agenda: "On the Properties of Liquid Mixtures," by R. A. Lehfeldt. "On certain Diffraction Fringes as applied to Micrometric Observations," by L. N. G. Filon. Electro-Harmonic Concert. Ladies' night.

Monday, November 28th.—At 8 p.m. Society of Arts. Cantor Lecture No. 2 on "Acetylene," by Prof. Vivian B. Lewes. The commercial production of acetylene; calcic carbide and its properties; the electric furnace and the various modifications in use for carbide manufacture; carbide without electrical power; carriage and storage of carbide.

Wednesday, November 30th.—At 4 p.m. Royal Society. Anniversary meeting. At 7 p.m.: annual dinner at Hotel Metropole.

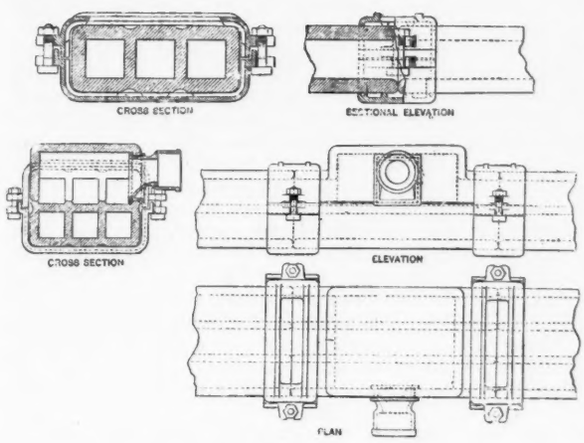
Tuesday, December 6th.—At 8 p.m. Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Discussion on "Dermatitis in Relation to Röntgen Ray Work," introduced by Mr. Ernest Payne and Dr. Walsh, who will read short papers on the subject.

Wednesday, December 7th.—Institution of Electrical Engineers. Annual Dinner, Grand Hall, Hotel Cecil.

NOTES.

High and Low Resistance Wires.—We beg to draw the attention of wire manufacturers to a letter, in our "Correspondence" columns, hailing from New York.

Belfast Electric Lighting.—We illustrate below the Doulton underground conduits and service boxes employed



in connection with the electric lighting installation at Belfast, referred to in another part of this issue.

The Röntgen Society's Conversazione.—This flourishing society held a successful conversazione at St. Martin's Hall on Monday last. The latest advances in Röntgen ray apparatus and work were illustrated by a large and interesting collection. The chief advance in focus tubes that strikes one is, that they are made much larger in size, and the platinum anti-cathode is mounted on the Swinton aluminium support. Mr. Mackenzie Davidson's tube, with an osmium anti-cathode, appears to be a distinct improvement. The osmium can stand a much higher temperature than platinum, and can therefore be placed nearer the exact focus of the cathode rays, a circumstance which contributes to the intensity and sharpness of the results. The apparatus of the Voltohm Company, Munich, was exhibited by the London Hospital. Its principal features are a mercury break worked by a small electro-motor, and a tube with a second bulb containing an anode, of which the use is not self-evident. Remarkable brilliant pictures were obtained on the screen with apparatus. Mr. Wimshurst exhibited an influence machine with 12 20-inch plates, and an improved Wimshurst machine with ball bearings, improved driving, and other constructive details was exhibited by Dr. Lewis Jones. A localising apparatus, of the same type as Mackenzie Davidson's, but much simpler, was exhibited by Mr. Coxeter. Experiments with the Tesla oscillator on vacuum tubes, destitute of electrodes, were exhibited by Prof. Silvanus Thompson. The tubes became luminous when placed between two vertical metal plates connected to the terminals of the oscillator. Wheatstone reflecting stereoscopes were applied by Mackenzie Davidson to throw into relief Röntgen photographs of hidden parts of our anatomy. Altogether, the exhibition showed a steady improvement in detail, though there was nothing strikingly new. The battle between the induction coil and the influence machine for the position as generator *par excellence* of X rays appears as yet to be undecided. The latter gives better results on the screen, but it is more cumbrous and more expensive than a coil to give equally good photographic results.

The Royal Society.—Among the papers down for reading yesterday afternoon was one by Mr. C. T. R. Wilson, "On the Condensation Nuclei produced in Gases by the Action of Röntgen Rays, Uranium Rays, Ultra-Violet Light, and other Agents."

Obituary.—We regret to announce the death of Sir John Fowler, which occurred on Sunday at Bournemouth, at the ripe old age of 81 years. Sir John's name will live in the memory of Englishmen as a pioneer in connection with some of the most important heavy engineering works carried out during the past century. The bare mention of so mighty a structure as the Forth Bridge, and of so difficult a work as the construction of the Metropolitan Underground Railway, is sufficient to denote the character and dimensions of his undertakings. His name will also be coupled with the heavy tunnelling operations in connection with the City and South London Railway, and the more recent Waterloo and City and Central London electric underground railways. At one period he acted as consulting engineer to the Khedive and the Egyptian Government, and for his work in this connection he was, in 1885, made a K.C.M.G. He was made a baronet in 1890, when the Forth Bridge was opened. In 1866 he was president of the Institution of Civil Engineers.

The death is announced in New York of Mr. Keely, of "Keely motor" fame.

American Institute of Electrical Engineers.—Mr. Kennelly, president of the above institute, recently announced to the members that a committee on co-operative research had been appointed in accordance with the Council's instructions. The committee consists of Dr. A. E. Kennelly, chairman; Prof. W. A. Anthony, Dr. F. B. Crocker, Dr. C. T. Hutchinson, Dr. Samuel Sheldon, Chas. P. Steinmetz, and Prof. E. Thomson. The purpose is to formulate a system of experimental research by submitting to various colleges and universities various problems which are of practical importance. The investigations are to be made as a part of undergraduate, graduate, or post-graduate work, under competent supervision. The committee starts off with a list of 16 subjects, and will expect members to send in others which may occur to them in the course of their practice. The results, when received, if deemed important, will be published in the *Transactions*. Our New York namesake says that the plan is receiving hearty support.

Personal.—Mr. Ivon M. de Havilland, late of the Oxford Electric Company, Limited, and previously with the Brush Electrical Engineering Company, Limited, has been appointed assistant to Mr. Albion T. Snell, consulting engineer.

Mr. H. T. Barnett is now on the staff of Mr. Lloyd Wise, chartered patent agent, as technical electrical assistant.

Mr. Arthur Fuller, burgh electrical engineer, Ayr, has been granted an increase in his salary of £50 a year. The motion for granting the increase was opposed, but the opposition elicited such a volume of testimony in Mr. Fuller's favour that it was withdrawn, and the increase granted unanimously. We congratulate Mr. Fuller in this matter.

The Council of King's College has appointed Mr. Ernest Wilson, M.I.E.E., professor of electrical engineering in succession to the late Dr. John Hopkinson. We scarcely see how the decision of the Council could have been otherwise, and we congratulate Mr. Wilson on the appointment.

We are very pleased to learn that Mr. Gustav Byng, of the General Electric Company, Limited, has benefitted by his stay in the country, and is now feeling much better.

Presentation.—Mr. Lee, the late electrical engineer at the Southampton Corporation electricity works, has been presented with a silver cigar, cigarette and vesta case by some of his friends on the Council and the staff at the works on the occasion of his leaving the works.

Tenders Wanted.—As we go to press we learn that the North-Eastern Railway is inviting tenders for telegraph apparatus, wire and stores, for six months. Forms of tender to be obtained from Mr. Graves, Telegraph Department, York.

Fire.—On Wednesday a fire destroyed the station buildings at the Sandon Dock station of the Liverpool Overhead Railway.

Appointment Vacant.—A resident electrical engineer (£250 per annum) is wanted by the Wimbledon District Council. See our "Official Notices."

The Institution of Electrical Engineers—Students' Section.—The annual general meeting was held on Wednesday, November 16th, at the Institution. It was unanimously passed: "That the hearty and sincere thanks of this meeting, as representing the students of the Institution, be accorded to Mr. S. S. Grant for the able and earnest manner in which he has fulfilled the position of secretary during the past year, and for the great interest he has taken in the students' future welfare." The following gentlemen were elected to serve on the new committee:—Messrs. M. R. Gardner, F. S. Miller, L. R. Morshead, A. Pope, W. G. Royal-Dawson, and M. Solomon (hon. sec.).

The Rise in the Price of Copper.—There has been considerable excitement in the copper market during the past month, as a result of the rapid advance in the price of G.M.B.'s. According to the last bi-monthly statement of Messrs. H. R. Merton & Co., the price of refined copper has risen 57s. 6d. per ton since October 15th. The price on that date was £52 17s. 6d. per ton; on the 31st of the same month it was £54 15s., and on November 15th it was £55 15s. This sharp rise is due to the facts that the consumption of copper has overtaken the supply, and that a gradual depletion of the stocks of refined copper ashore and afloat is occurring. Three years ago there were 50,383 tons of copper in stock at the various ports in England and France, and afloat for these ports. Twelve months later the corresponding total was only 35,441; on October 31st, 1897, it was 34,389, and on October 31st, 1898, it had fallen to 25,798 tons. This depletion of stocks has been going on, in spite of the greatly increased shipments to Europe in recent years from America and Australia. The total supplies of copper for the years 1895—1897 have been, according to Messrs. Merton & Co., 334,565, 373,863, and 396,728 tons respectively. The large number of electric traction schemes at present in course of development in England, and the still larger number of electrical schemes of all kinds now being carried out upon the Continent of Europe, are the chief factors in causing this scarcity of copper, and consequent rise in price. It is impossible to say how far the latter may advance, but it will doubtless greatly stimulate production in all countries, and will lead to mines being reopened in countries like Australia, where the costs of production are relatively high, and where mines, in consequence, have been closed. It may also lead to increased use of aluminium for electrical purposes, and in this connection, the article in our issue of September 2nd upon the relative costs of conductors, and the letters it called forth, are of interest. We shall look for a great increase in the shipments from Australasia, as a result of this advance in the price of copper. The output for 1897 was 50 per cent. greater than that of 1896, and under this added stimulus, the total of 17,000 tons for 1897 ought to be greatly exceeded in 1898.

Sine Waves on Ocean Cables.—The *Electrical World* says that the Crehore and Squier synchronograph has recently been tested on the submarine cable of the Commercial Cable Company running between New York City and Canso, Newfoundland. A simple sinusoidal wave of impressed electromotive force is expected to give higher speed on cables with the same dielectric strain as it does on overhead lines with the same impressed electromotive force.

Automatic Water Gauge.—We have received from Messrs. J. Hopkinson & Co., of Huddersfield, their new descriptive list of water gauge fittings. The importance of correctly registering the water level in a steam boiler cannot be over-estimated, and this is best secured by fittings of good design and ample dimensions of the kind described. The safeguards, in event of glass breakages, are illustrated, and we can recommend the perusal of this list to all who have charge in any way of steam boilers.

Society of Arts.—On Wednesday evening Prof. Geo. Forbes read a paper on "Electrical Transmission of Power." A discussion followed.

Appointment.—The Worcester City Council has appointed Mr. C. J. Sutherland, of Hanley, electrical engineer at £350 per annum.

Lectures.—At Glasgow last week, Dr. J. T. Bottomley delivered his presidential address to the University Physical Society. His subject was "Electric Tramways," with special reference to the overhead trolley system recently opened in Glasgow.

On 14th inst. at Glasgow, Mr. T. C. Fulton delivered the first of a series of lectures to the members of the West of Scotland Engine-Keepers' Association, on "Electricity as a Force."

Electrical Transmission of Power in Mining.—At the ordinary meeting of the Institution of Civil Engineers on November 15th, Mr. W. B. Esson read a paper describing an interesting installation at the mine of the Sheba Gold Mining Company, South Africa, transmitting 450 horse-power a distance of five miles. This is one of the cases wherein a polyphase system would prove most advantageous. A two-phase system was adopted, with the result that the cost of milling per ton of ore was reduced from 6s. 1d. to 1s. 8d. per ton. Formerly the ore was carried to the source of the power; now the power is electrically conveyed to the ore, hence the vast saving. The water-power which works the generators is on the Queen's River, two miles above the power house, giving a fall of 32 feet to work the turbines. It was found that the self and mutual induction on overhead lines interfered with the working, causing a large fall in pressure; but the substitution of underground concentric cables completely abolished these troubles. The total efficiency from turbine shaft to motor shafts is said to be 70 per cent. The high pressure is about 3,000 volts, and the low pressure at the mine 100 volts. Altogether, the plant seems to have been engineered by great skill and foresight, with most gratifying results.

Allgemeine Electricitäts-Gesellschaft.—The annual report of the Allgemeine Electricitäts-Gesellschaft, made public last week, contains some statistics which reflect the extremely rapid development of the electrical industry in Germany. This company employed in its factories in 1889 422 working men, by 1895 the number had reached 2,478, and it has now further risen to 6,011. Including the employés outside the factories, there are now over 12,000 names on the pay-rolls. Still more striking, says the *Economist*, are the statistics of production. In 1889-90 the company produced 507 dynamos and electrical motors with a total of 8,650 horse-power; in 1895-6, 4,000 machines of 68,000 horse-power; and in 1897-8, 8,328 machines of 152,900 horse-power. The company is represented in 139 domestic and foreign cities, and at the end of June it had no less than 55 electric railways completed and building. The length of its lines increased during the year from 766 to 1,095 kilometres, and the number of motor cars from 1,243 to 1,861. The manufacture of electric motors for ordinary broad gauged railways has been begun as a regular department of factory work. Another innovation is the use of electricity in driving the rollers in the company's factory for rolling copper. This is said to be so highly successful that other companies will adopt the process.

Cost of Electricity at Blackpool Winter Gardens.—The letter which we printed in our last issue from the company's consulting engineers is enlightening, but scarcely satisfactory. Some interesting details are given, but the most important detail of all—that of the means by which the consumption has been ascertained—is omitted altogether, probably by inadvertence. We are, however, surprised to hear that the company have a reserve of not less than 245 kilowatts, and that their lighting hours are 24 hours per day! From another source we are also surprised to learn that in addition to this reserve the company have a large battery installation (which may account for a good deal of the current charged for); and as explaining their low coal and water costs, that steam from the "lighting" boilers has been supplied to their heating apparatus, and doubtless charged for liberally, in the same way as the engineer's salary has been charged to the lamps installation account. As, however, we are assured the figures we criticised are incorrect, and were not those supplied to the directors of the company, we do not see the necessity of discussing the subject further.

The Hart Secondary Battery.—We have before us a brief report of efficiency tests of an 11-plate standard lighting type Hart battery carried out by Mr. Hugh Erat Harrison at the Electrical Standardising Institution. The cell was charged and discharged four times each at a current of 25 amperes, the discharges being considered complete when the open circuit E.M.F. had fallen to 1·80 volt. The results of the measurements of the final charge and discharge are given in table form. The ampere-hour efficiency was 91·5 per cent., and the watt-hour efficiency 77·7 per cent. The listed maximum discharge rate is 40 amperes.

Glasgow and West of Scotland Technical College.—An ordinary meeting of the above society was held on Saturday evening, 19th inst., the president, Mr. David Home Morton, M.I.C.E., M.I.M.E., in the chair. Mr. Andrew Stewart read his paper on "Multiphase Electrical Machinery," which had been awarded the society's gold medal by the judges. Mr. Stewart dealt with generators (two and three-phase), pointing out their leading features and their performance in practice. Dealing with motors, Mr. Stewart, by means of diagrams, showed their method of action and the chief points in their regulation and efficiency. The action of two-phase motors when used with condensers was shown by means of diagrams, and the improvement of the power-factor was specially pointed out. The paper was illustrated by lantern slides and wall diagrams, and an interesting discussion followed. Mr. Stewart was awarded a hearty vote of thanks for his paper.

Hot Water or Exhaust Steam ?—It would be interesting to learn whether there is any foundation for the allegation made by Mr. Watson at the last meeting of the Vestry of St. James, Westminster, to the effect that the St. James and Pall Mall Company are passing steam into the sewers in Carnaby Street. The surveyor, Mr. Monson, is not aware of this being done, but he has ascertained that hot water, from which steam is given off, has found its way into the sewers. But surely if the gullies are properly trapped, the steam should not rise 4 feet above the level of the carrisgeway.

NEW COMPANIES REGISTERED.

Dutton & Co., Limited (59,448).—This company was registered on November 7th, with a capital of £21,000 in £1 shares, to adopt an agreement with Dutton & Co., Limited (registered in 1889), for the acquisition of its business, and to carry on the business of mechanical engineers, electricians, and manufacturers of railway and other signals, locking, safety, and detecting apparatus, electrical and other lamps, dynamos, electrical and magnetic apparatus, &c. The first subscribers (with one share each) are:—Ralph H. C. Nevile, J.P., and Mrs. Mildred F. Nevile, Crown Lea, Malvern; Charles Dutton, Tolladine Road, Worcester, signal engineer; William Buck, Carisbrooke, Worcester, engineer; Samuel T. Dutton, Marl Bank, Worcester, engineer; Sutton G. Corkran, Britannia Square, Worcester, gentleman; Geo. W. Bull, Langherne Road, Worcester, accountant. The first directors (to number not less than two nor more than five) are Charles A. S. Murray, Sutton G. Corkran, Samuel T. Dutton, and Ralph H. C. Nevile; qualification, £100; remuneration, £50 each per annum.

Tourtel Manufacturing Company, Limited (59,472).—This company was registered on November 9th, with a capital of £18,000 in £1 shares, to acquire the English business of engineers and meter apparatus manufacturers now carried on at 67, Aldersgate Street, E.C., by "The Tourtel Gas and General Engineering Company, Limited," and to carry on business as electrical and mechanical engineers, electricians, electrical apparatus makers, suppliers of electricity, &c. The first subscribers (with one share each) are:—Arthur F. Davies, 82A, New Bond Street, W., gentleman; Frank S. Springell, 14, Sinclair Road, Kensington, gentleman; John M. Tourtel, 67, Aldersgate Street, E.C., engineer; Dixon H. Davies, Chesterfield, solicitor; Charles E. Smith, 9, Abercorn Terrace, Upper Holloway, N., foreman; Matthew Sharpe, 84, Vartry Road, South Tottenham, clerk; and George Stebbing, 6, Upstall Street, Myatt's Fields, S.E., clerk. The first directors (to number not less than three nor more than six) are Arthur F. Davies, John E. Rombach, and John M. Tourtel. Remuneration two guineas each per board meeting attended.

Steel Nut and Tube Company, Limited (59,480).—This company was registered on November 9th, with a capital of £50,000 in £1 shares, to acquire the business carried on at Openshaw, Lancashire, by "The Manchester Steel Nut and Tube Company, Limited," to enter into an agreement with Charles W. Milne, and to carry on the business of steel nut, tube, and hollow shafting manufacturers, ironmasters, mechanical, electrical, hydraulic, and marine engineers, bridge builders, machinists, locomotive and waggon builders, boiler makers, iron, copper, and brass founders, &c. The first subscribers (with one share each) are:—Charles W. Milne, 51, Linden Gardens, Bayswater, W., gentleman; Geo. McFarlane, 121, West George Street, Glasgow, engineer; William H. Aston, 46, Eagle Wharf Road, New North Road, N., engineer; John Mudd, 69, Vine Street, Openshaw, Manchester, engineer; David A. Bremner, 3, Crown Court, Old Broad Street, E.C., engineer; William R. Gaff, 3, Crown Court, Old Broad Street, E.C., chartered accountant; Sylvester D. Stirling, 3, Crown Court, Old Broad Street, E.C., chartered accountant. The first directors (to number not less than three nor more than seven) are Charles W. Milne, George McFarlane, William H. Aston and John Mudd; qualification, £500; remuneration, £150 per annum (an extra £250 for the chairman) and a share in the profits.

Himalaya Electric Railway, Limited (59,538).—This company was registered on November 15th, with a capital of £2,000 in £1 shares, to enter into an agreement with Paul Violi, and to acquire, develop, work, turn to account, and deal with an invention known as "The Himalaya Electric Railway," and a railway and accessories erected at the Tower Grounds, New Brighton, Cheshire, under the said invention. The first subscribers (each with one share) are:—Paul Violi, 22, Molyneux Drive, New Brighton, Cheshire, merchant; Mrs. Anna Violi, 22, Molyneux Drive, New Brighton, Cheshire; Guilio Spagnuoli, 22, Molyneux Drive, New Brighton, Cheshire, engineer; William W. Turner, 131, Moscow Drive, Liverpool, book-keeper; Henry Hodson, 41, Alderson Road, Liverpool, book-keeper; Arnold H. Sewards, 22, Cranborne Road, Liverpool, book-keeper; and Robert H. Davy, 38, Leopold Road, Kensington, Liverpool, accountant. Table "A" mainly applies.

Stock, Sons & Taylors, Limited (59,544).—This company was registered on November 15th, with a capital of £37,200 in £10 shares (of which 1,420 are 5 per cent. cumulative preference), to acquire and take over as a going concern the business now carried on under the style or firm of "Stock, Sons & Taylors," at Gas Street and Berkeley Street, Birmingham, to carry on the business of glass, lead, oil, and colour merchants, mechanical, electrical, light, heat, and water-supply engineers, machinists, boiler makers, millwrights, iron and brass founders, &c., and to enter into an agreement with Thomas S. Stock, Walter Stock, Bernard Stock, Henry W. Taylor, and Thomas L. Taylor. The first subscribers (each with one share) are:—Thomas S. Stock, The Priory, Northfield, Worcestershire, merchant; Bernard Stock, King's Norton, Worcestershire, lead merchant; Henry W. Taylor, Leahyrst, Blackwall, near Broomsgrove, lead merchant; Thos. L. Taylor, Leahyrst, Blackwall, near Bromsgrove, lead merchant; Joseph S. Stock, Walmer, Kent, gentleman; Miss Mary L. Taylor, Leahyrst, Blackwell, near Bromsgrove; and Mrs. Bernard Stock, King's Norton, Worcestershire. The first directors (to number not less than two nor more than five) are Thomas S. Stock, Bernard Stock, Henry W. Taylor, and Thomas L. Taylor; qualification, £1,000; remuneration, £500 per annum for Bernard Stock and £100 each for the other directors.

Cecil Wray & Co., Limited (59,574).—This company was registered on November 17th, with a capital of £3,000 in £1 shares, to acquire, take over as a going concern, and carry on the business carried on by Cecil W. Baxter and Cecil Wray, at Borough Mills, Bradford, as manufacturing opticians, electricians, electrical engineers, and manufacturers of and dealers in cinematographs, films, optical lanterns, slides, and phonographic apparatus. The first subscribers (each with one share) are:—Thomas Middlebrook, 36, Sunbridge Road, Bradford, accountant; George B. Russell, 9, Darley Street, Bradford, printer; James H. Oulton, 8, Hillside Terrace, Bradford, clockmaker; Joseph Oulton, 8, Hillside Terrace, Bradford, clockmaker; Mrs. Eliza Wray, 80, Grange Road, Bradford; William T. Sykes, 74, Westgate, Bradford, draper; and William Wray, 36, Horton Lane, Bradford, traveller. Registered without articles of association.

CITY NOTES.

Hampstead Electric Supply Company.

The first ordinary general (statutory) meeting of this company was held on Monday at the Westminster Palace Hotel, Victoria Street, S.W., under the presidency of Mr. J. Soares.

The Chairman said: As you are aware, the Companies' Acts require a meeting of the shareholders to be called within four months of the incorporation of the company. We have, therefore, called you here to-day principally to comply with the terms of the Act. This statutory meeting is only a formal one, at which it is not possible as a rule for the directors, who have practically only just got into harness, to give much information as to the past working of the company, but we, nevertheless, have much pleasure in putting before you as much information as possible at this early stage of the company's existence. You will remember that in the prospectus we gave prominence to the very important fact that our company is in the strong position that it cannot be interfered with by the local authorities in the way of compulsory purchase. This is so, and this fact alone should considerably add to the value of the shares from the point of view of the investor. There is less speculation in the holding of shares of an established undertaking, the goodwill of which has not to lapse at the end of a certain number of years, as is the case with most

other electric lighting companies. The great advantage which shareholders in electric lighting companies have over shareholders in other industrial concerns, is that their profits not only do not fluctuate, but necessarily increase each year of the company's existence. You will also remember that at the date of the prospectus we had in operation the respectable figure of 33 miles of mains. This, of course, has now been considerably added to. To go further into figures, and taking the latest information available, the increase in the number of houses supplied since March 31st is no less than 168, and there are contracts in hand for connecting with 400 more. We anticipate that we shall soon require to make still further extensions, and without in any way interfering with our existing premises. I may state that the land beyond the boiler house is available, without further cost, for the erection of a range of five more boilers; in fact, the unoccupied land will suffice for at least 1,000 kilowatts more, and then, as you know, in addition to this, we have the very valuable premises of Messrs. Taylor & Lown's, whose business is a most profitable and progressive one. Those of you who reside in the large area covered by our company in Hampstead must have observed that in the main road, almost adjoining the Finchley Road railway station, and in close proximity to this company's central supply station, a large store (to be conducted, I believe, on similar lines to John Barker & Co. and Harrod's Stores) is in course of construction, and is shortly to be opened. We are in treaty for the supply of electric current, not only for the lifts, but for the electric lighting throughout. There is also another and larger undertaking of a different character in the neighbourhood, for which we hope to obtain a contract. We have, of course, adequate working capital for the extensions and for undertaking these large contracts. Perhaps I have gone more fully into the affairs of the company than is usual at a statutory meeting, but I consider that shareholders should always be taken into the confidence of the directors when possible, and I have now only to assure you that the board will always be unremitting in their endeavours to promote your interests, and to justify the prospects referred to in the prospectus. I may add, in conclusion, that the brokers to the company will be instructed to apply for a special settlement and quotation of the company's shares.

Mr. E. T. Read proposed a vote of thanks.

Mr. G. Ricketts seconded the motion, which was unanimously adopted.

An extraordinary general meeting was subsequently held, for the purpose of amending clause 65 of the articles of association of the company, as follows:—"The directors may, whenever they think fit, and they shall, upon a requisition made in writing by members holding in the aggregate one-tenth of the then issued capital, convene an extraordinary general meeting."

The Chairman moved the resolution, and stated that the alteration was necessary in order to comply with the Stock Exchange requirements.

Mr. Read seconded the resolution, which was carried unanimously.

The proceedings then terminated.

Cuba Submarine Telegraph Company.

Mr. Charles W. Parish, chairman of the company, presided over the fifty-fourth ordinary general meeting of the proprietors, which was held on Wednesday at the offices in Old Broad Street.

The Chairman said the board were glad to be able to present such a satisfactory report, notwithstanding the anxious period through which they had passed since the last meeting. The insurrection which broke out in the island in February, 1895, was in full force at the commencement of this year, and its continuance led to the outbreak of the war in April last. On the outbreak of hostilities the American Government practically took control of the cables of the Western Union Company at Key West, Havana, and Florida, and instituted a strict censorship over all messages, none being allowed in cypher. This compelled the Spanish authorities at Havana to send their cable messages *viâ* Santiago and Jamaica, and that unexpected diversion of traffic caused an increase in the receipts of the company. The American authorities then set to work to isolate Cuba as far as possible from the outside world, and also to separate each chief town from the other where cable communication existed. The unfortunate result was that many of their cables were cut, and their cable hut at Cienfuegos was entirely destroyed by the bombardment of the American fleet. It was with satisfaction that he was able to testify to the admirable way in which their staff kept to their posts under the most trying circumstances. They were able to maintain communication from Havana and Jamaica right through the war. When the Americans entered Santiago after the capitulation of July 17th, they were greatly surprised to find the company's cables still working. On hearing that they belonged to an English company, they contented themselves with sealing them up. That, however, stopped their through traffic for about three months. At Santiago and Manzanillo their representatives were able to do a real service to the cause of peace by keeping to their posts, and the fact that they had so stayed during a trying period had been recognised by both the Spanish and American generals. The directors had thought it right to recognise this service, and to help their staff to meet the exceptional expenses of the time. Since the termination of hostilities they have been able to repair damaged cables, with the exception of the Cienfuegos-Casilda section and the 1891 cable between Cienfuegos and Batabano. The breaks in these cables were in deep water, and would require the services of a regular cable steamer to enable them to be repaired, and the directors were now arranging to send one out. Directly the board learned of the damage to their property, they put themselves in communication with the Foreign Office, with the view of obtaining the assistance of that department in the claim which they would make on the American Government. He could not tell the shareholders that their claim would be admitted, but he was certain that the Foreign Office would do their utmost. Since the cessation of hostilities and the change of Government at Cuba the position of the company with regard to the subsidy had received the best attention of the board, who had taken steps to bring before the United States Government the rights of the company to the subsidy they had previously received, which was in the form of a charge on the Havana Treasury. Turning to the accounts, the chairman referred to the fact that the gross income had been £33,504, as against £25,623 in the corresponding period of the previous year. The expenses had amounted £8,091, against £7,005 in the previous year. The reserve fund had been drawn upon during the present year, but it now stood at £110,000, as against £110,000 on June 30th of last year. In view of the special circumstances which had increased their receipts this year, the directors had thought it better to give a bonus in addition to the dividend, and he hoped they would agree with him that they must rely on peace to give them prosperity in the future rather than on the terrible exigencies of war.

In reply to questions, the Chairman said at present there appeared no chance of the company losing its subsidy. He should be greatly disappointed if it did. As to the future of the company, they would bear in mind the competition they now had to meet. Formerly they received 5*s.* 2d. per word for messages to Cuba, now they had to take 3*s.*

The report was adopted, and the retiring directors and auditors re-elected.

Yorkshire House-to-House Electricity Company.—The shareholders of the Yorkshire House-to-House Electricity Company, Limited, met on Monday last at the offices of the company in Whitehall Road, Leeds, when the provisional agreement for the purchase of the business by the Leeds Corporation was considered. On the motion of the chairman, Mr. Grosvenor Talbot, seconded by Mr. Crowther, the transfer was unanimously agreed to, and a vote of thanks to the chairman and directors was also adopted.

Prospectus.—The British Columbia Electric Railway Company, Limited, has this week issued a prospectus of 12,000 non-cumulative 5 per cent. preference shares of £10 each, ranking for additional dividend rateably with the ordinary shares after the ordinary shares have received 7 per cent. The price is £11 per share. The proceeds of the present issue will be applied as to £60,000 in redeeming the non-cumulative 6 per cent. income bonds outstanding, and as to £55,000 (more or less) in carrying out certain extensions and improvements.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in and to grant a quotation to Blackheath and Greenwich District Electric Light Company, Limited—100,000 ordinary shares of £1 each, fully paid; British Electric Traction Company, Limited—£100,000 5 per cent. perpetual debenture stock.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending November 19th, 1898, were £201 8*s.* 9d.; aggregate to date, £13,566 19*s.*

The Bradford Corporation Tramways.—The receipts for the week ending November 20th, 1898, were £275 5*s.* 8d.; mileage, 5,952 miles; average per mile, 11·1d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending November 18th, 1898, were £2,667 19*s.* 6d.; corresponding period, 1897, £2,553 11*s.* 9d.; increase, £114 7*s.* 9d.

The City and South London Railway Company.—The receipts for the week ending November 20th, 1898, were £1,044; week ending November 21st, 1897, £1,063; decrease, £19; total receipts for half-year, 1898, £20,405; corresponding period, 1897, £19,725; increase, £680. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending November 19th, 1898, were £150 9*s.* 11d.; week ending November 20th, 1897, £99 17*s.* 8d; increase, £50 12*s.* 3d.; total receipts to date, 1898, £7,653 13*s.* 9d. Miles of track open week ending November 19th, 1898, 3; week ending November 20th, 1897, 2. Car miles run week ending November 19th, 1898, 4,363; week ending November 20th, 1897, 1,902. Number of cars week ending November 19th, 1898, 11; week ending November 20th, 1897, 5.

The Dublin United Tramways Company.—The receipts for the week ending November 18th, 1898, were as follows:—D. U. T. Co., horse cars, £2,289 4*s.* 5d.; ditto, electric cars, £330 18*s.* 6d.; D. S. D. Co., electric cars, £672 0*s.* 10d.; total, £3,292 3*s.* 9d; corresponding week last year—D. U. T. Co., horse cars, £2 551 12*s.* 7d.; ditto, electric cars, £134 19*s.* 3d.; D. S. D. Co., electric cars, £378 8*s.* 11d.; total, £3,065 0*s.* 9d.; increase, £227 3*s.*; aggregate to date, £82,624 12*s.* 10d.; aggregate to date last year, £76,252 11*s.* 8d.; increase to date, £6,372 1*s.* 2d. Worked:—The mileage open is 13 miles electrically, 31 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending November 16th, 1898, were £234; total receipts to date, 1898, from June 29th, £5,408. Miles of track open, 3½. Car miles run, 3,604. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending November 20th, 1898, amounted to £1,358; corresponding week last year, £1,326; increase, £32.

The South Staffordshire Tramways Company.—The receipts for the week ending November 18th, 1898, were £631 17*s.* 1d.; week ending November 19th, 1897, £588 15*s.*; aggregate receipts for 46 weeks, £29,179 9*s.*; last year, £29,318 5*s.* 11d.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending November 18th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,870.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Nov. 16th.	Closing Quotation, Nov. 23rd.	Business done during week ended Nov. 23rd, 1898. Highest.	Lowest.
127,400*l*	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	101 —105	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3½— 4½	3 — 4	4½	3½
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
905,560*l*	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	63 — 66	63 — 66	65	63
3,047,220*l*	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	114 —115	114 —115	114⅜	114
3,047,220*l*	Do. do. Deferred...	Stock	...	...	...	15¼— 15¾	15½— 15¾	15 $^{9}/_{16}$	15⅝
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15¾	15½— 15¾	15⅝	15¼
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	111 —115	111 —115	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105¾	105
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	$^{1}/_{16}$— $^{3}/_{16}$	$^{1}/_{16}$— $^{3}/_{16}$	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	10 — 11	10½— 11½	10⅝	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	16½— 17½	17 — 18	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	104 —107%	104 —107%	...	...
60,710*l*	Direct United States Cable	20	2½ %	2½ %	...	11½— 12	11½— 12	11⅞	11⅝
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	101 —104	102—105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	172 —177	172 —177	176	173⅜
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	104 —107	104 —107	104⅜	104½
500,000	Do. Prov. Certs., 50 % paid	...	...	...	...	53 — 56	53 — 56	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	101 —104	101 —104	...	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —128	124 —128	127½	125½
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17¼— 17¾	17¼— 17¾	17¾	17½
16,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
64,400*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	126	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	102 —105	102 —105	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	102 —105%	102 —105%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12 — 12½	12½— 12⅝	12⅝	12⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16½— 17	16½— 17	17	16½
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	28½	...
150,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,800	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., ¼ w'n. 1-1,200, rd.	100	...	...	...	101 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	54 —57	54 — 57	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5¼— 5½	5⅜— 5⅝	5 $^{9}/_{16}$	5⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	13⅜	13
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛— 5⅜	5¼— 5½	5⅜	5 $^{5}/_{16}$
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —105	100—103	102½	101¾
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	133 —138	133 —138	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4¾	4¼— 4¾	4 $^{9}/_{16}$	...
151,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —106	103 —106	...	...
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ¾	¼— ¾	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	104 —107	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12¼— 12⅜	12¼— 12⅜	12⅝	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	½ %	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Telegraph	10	½ %	1 %	½ %	1⅛— 1⅜	1⅛— 1⅜	1 $^{5}/_{16}$	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	9½— 10	9½— 10	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	7 — 9	7 — 9	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	11½— 12½	11½— 12½	12	11⅞
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	5 %	6 %	8 — 9	8 — 9	8⅝	8⅜
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	113 —115	114 —116	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24 — 25	24 — 25	24⅜	24¼
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	23½— 24½	23½— 24½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	16	15⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	127 —132	127 — 132	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	nil	12½— 13½	12½— 13½	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £8 paid.	10	...	...	...	10 — 11	10 — 11	10 $^{7}/_{16}$	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14½— 15½	14½— 15½	14⅜	14⅜
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	...	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	...	4 %	9 — 10	9 — 10	9 $^{7}/_{16}$	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6¼— 6¾	6 — 6½	6⅝	6¼
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	16 — 17	16½— 17½	17	16⅞
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	15 — 16	15½— 16½	15⅞	...
31,980	*St. James's and Pall-Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	16½— 17½	16½— 17½	17	16 $^{15}/_{16}$
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	16⅜	16

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Nov. 16th.	Closing Quotation Nov. 23rd.	Business done during week ended Nov. 23rd, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3 1/16	...
90,000	Do. 4¼ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	16½— 17½	15½— 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 14	12½— 13½	13⅝	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅜— 2	1⅜— 2	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜	2⅛— 2⅜	2 3/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	109 —113	111 —115	112	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —113	110 —113	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10¼	...
178,303	Do. do. do. £6 paid	10	...	...	...	5¾— 6¼	5¾— 6¼	...	...
61,033	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4½— 5	4½— 5	4 9/16	4½
630,000*l*	City and South London Railway	Stock	1 3/16%	1 9/16%	1⅛%	69 — 71	68 — 70	70	68
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1½— 2	1½— 2	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	91 — 96	91 — 96	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	6 %	2 — 2½	2 — 2½	2⅜	2⅛
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	99 —101	99 —101	98½	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2½— 2⅝	2½— 2½	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2⅝— 3⅛	2⅝— 3⅛	3	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	106½	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ½	¼— ½	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20 — 21	20 — 21	20⅞	20¼
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	114½	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	22 — 23	22 — 23	22¾	22¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10 7/16— 10 9/16	10 3/16— 10 3/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	38½	38
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	107 —112	107 —112	111½	110½

† Quotations on Liverpool Stock Exchange.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—13.
House-to-House, 4½% Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7⅞—8¼. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 7s.—9s.
Smithfield Market Electric, 2—4.
*T. Parker, £10 (fully paid), 14—15.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6%.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (October 13th, 1898).

MARKET QUOTATIONS, Wednesday, November 23rd.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. per ton	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£14 10	£14 10	..
a Benzole (90 %) .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£19	£19	..
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3½d.	3½d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	65/-	65/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 10	£6 10	..
a „ Recovered .. .. per ton	£5 10	£5 10	..
a „ Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis per lb.	6¾d.	6¾d.	..
c „ Tube (brazed) .. .. per lb.	8¾d.	8¾d.	..
c „ Wire, basis .. .. per lb.	7d.	7d.	..
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£67	£67	..
g „ Wire (basis price) .. per lb.	8d.	8d.	..
g „ Sheet .. .. .. per ton	£67	£67	..
g „ Rod .. .. .. per ton	£67	£67	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	5/6	5/6	..
h India-rubber, Para fine .. per lb.	3/11 forw'd	3/10½ forw'd	½d. inc.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	52/6	50/4½	2/1½ inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13 12 6	£13 12 6	..
g „ „ Sheet .. .. per ton	£14 12 6	£14 12 6	..
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£7 9	£7 9	..
o Platinum .. .. per oz.	£2 19	£2 17 6	1/6 inc.
i Steel, Magnet, according to description .. .. .. per ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£84 to £85	£85 10	dec.
g „ foil .. .. per lb.	1/3	1/3	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/4	1/4	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
„ Flax, 6 or 8 lea... .. per lb.	3¾d.	3¾d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3¾d.	3¾d.	..
j „ „ Russian, 10 lbs. .. per lb.	4¼d.	4¼d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£30	£30	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£29 10	£29 10	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co Ltd
g „ „ „ Messrs. James & Shakspeare.
h „ „ „ „ Jackson & Till.
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson, Matthey & Co., Ltd

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

EXPERIMENTS ON THE INFLUENCE OF ELECTRICITY ON GROWING VEGETABLES OR PLANTS.

By Selim Lemström,
Professor of Physics at the University of Helsingfors.

Read before Section A.

(*Continued from page* 688.)

The Experiments.

The first experiments, the aim of which was to try the usefulness of the method, were carried out in the physical laboratory of the University in Helsingfors. Omitting a number of experiments, the results of which only encouraged us to continue further, we will go over to the first definite experiment made from the beginning of May to June 24th, 1885.

I. Before a window, looking to the south, three small compartments of cardboard were constructed, and on a table within were placed two flower pots in each compartment. In these pots were sown barley, wheat and rye, four grains of each sort. The grains of every kind were of the same weight and appearance. Over the pots was hung a net of wires provided with points, separated from each other and insulated. The soil in the pots was in such way connected with the earth by tinfoil, that, when we call the compartments: I., II., III., the electrical current from the positive pole of a Holtz machine was going in—

I.—From the points in the air to the soil.

II.—From the soil in the pot to the points.

III.—Without wires. The negative pole of the machine was conducted to earth.

They were watered with water of the same temperature and of the same quantity in every pot. After certain intervals the plants were measured as to their height and the leaves, both as to breadth and length.

A week passed. We could already see a remarkable difference. The plants in the compartments I. and II. developed much more strongly and more rapidly than in III. The electrical machine was kept working five hours daily. The experiments were continued to June 24th, whereby the increase of vegetation in I. and II. under the current was estimated to be 40 per cent. beyond the result in III. When the soil in the six pots was exactly alike, the cause of the greater development must be sought in the electric current.

The difference between I. and II. was barely perceptible, though the current in I. was + and in II. −. It seems, hence, that the difference, which in earlier experiments was found between + E and − E is not real. The experiments on which this conclusion was founded must also have been influenced by some secondary circumstance not stated.

II.—In the summer, 1885, the first experiments were performed on a field. This was a little barley field on the farm of Mr. W. Lemström, in the parish of Vichtis, in the south of Finland.

Though the external circumstances were unfavourable, dryness being prevalent,* the results were very satisfactory, the part of the field under the current giving an increase of about 35 per cent. to 36 per cent.

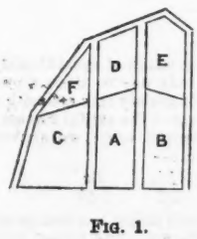


Fig. 1.

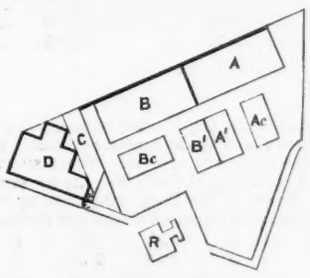


Fig. 2.

In every corner of the square A, fig. 1, was put a pole, on which a little cylinder of India rubber was fixed with iron wire by a hole in its end. Through holes in the other ends was conducted a wire around the square, and thus insulated from the poles. In every 1·5 metre cross wires were laid out, and from this wire net an insulated wire was conducted to the + pole of a Holtz machine with four plates, the − pole being conducted to earth by means of a little zinc plate. With the charged machine in movement the electricity was forced to go from the points in the air. At the beginning of the experiments the young shoots of the barley had a length of 9 to 10 cm., but the vegetation was not uniform. If we rate the vegetation on B as 10, it must be represented on A with 8, on C with 6; on D and E it was about the same as on C, but on F it was so poor, that this lot is to be excluded. During the experiments the lot, A, was by-and-bye improved.

* That dryness would be unfavourable was not known about this time, but this will be seen later on.

The table shows the harvest result:—

Squares.	Area in m².	Harvest in hl.	Harvest in kg.	Harvest in kg. per m².
A	110·77	0·178	11·084	0·1001
B	115·65	0·165	9·988	0·0864
C	137·80	0·146	8·874	0·0701
D + E	227·50	0·220	13·226	0·0581

The crop of A surpassed that of B with 15·9 per cent., that of C with 55·7 per cent., and that of D + E with 72·1 per cent. If we take the field of control together as follows:

$$\frac{2\,B + C + (D + E)}{4}$$

the surplus of A is 35·5 per cent., without considering the want of uniformity of the *squares* at the beginning.

III.—In the summer, 1886, the experiments were executed on a garden field belonging to the Garden Society in Helsingfors. The plants which came under treatment in the way that half a garden bed of about 7 m. in length was under the current, the other half serving as control, were following with the results given in per cent:—

Table of Results of the Experiments.

Kind of plants.	Lots of experiment.		Lots of control.		Increase.
	No. of plants	Weight in kg.	No. of plants	Weight in kg.	
White beets	56	31·982	157	43 343	107 2 %
Potatoes	268	21 281	990	44 694	76·2 %
Red beets	107	24 600	263	36·551	65·29 %
Radish	26	2 295	57	3 166	59 1 %
Parsnips	181	16 205	507	29·067	54·45 %
Onions	51	7 705	98	10·425	42·11 %
Celery	45	22 207	98	35 722	36 90 %
Garden-strawberries in a greenhouse	...	...	...	...	...
Carrots	695	27·201	1·009	41 438	− 5·12 %
Turnip-cabbage	8	2 869	16	5·382	− 5 23 %
Cabbage	13	14 025	15	28·684	− 43 58 %
Turnip-cabbage	15	14 72	23	21·19	+ 1 8 %
Turnip	91	4 356	163	7·459	+ 2 58 %

A singular circumstance was, that we could not, during the summer, see any difference between the experimental and the control field, and we were on the point of believing that no difference at all would appear in the harvest, but from the table above it seems that it was very great.

The most remarkable fact in this table is, that some of the plants seem as though favoured by the electricity, while others are left without any benefit and are even damaged by it. Among these last mentioned the cabbage is pre-eminent. It is, however, not necessary to discuss this inequality here, as it was later discovered that it had its cause in the want of water.

The strawberries, planted in pots, were in a greenhouse and ranged in three compartments, separated from each other by walls of cardboard. In every compartment were two pots, and in the

1st + E, in the 2nd − E was given, the 3rd was without E.

The berries ripened in the 1st in 28 days, in the 2nd in 33 days, and in the 3rd in 54 days.

The effect of the current was to shorten in an astonishing manner the time of ripening. Here we have a marked difference between the + E and the − E, the former giving a stronger effect.

In the same summer a first experiment was performed on the estate of Brödtorp, in the parish Pojo, in the south of Finland, whose owner, the Baron E. Hisinger, we had the happiness to interest in the experiments, and to whom we are under a great obligation for assistance in all directions given with the utmost courtesy and kindness.

The experiments, executed on a wheat field of exceptionally good development, began first on June 20th, when the wheat was just flowering. When the crop was sifted in 1 ma. and 2 da. quality the result was:

On the experimental field 0·5 ha.	On the control field 0·5 ha.
1226·2 kg.	1292 5
198·1 kg. 1 ma., 1028·1 kg. 2 a.	126·1 kg. 1 ma, 1166·4 kg. 2 a.

Because the experiments began as late as in the time of flowering of the wheat, an increase of the total crop could not be expected, but only an improvement in quality. That has really been the case, then we find that the 1 ma. quality is augmented on the experimental field by 57 per cent.

V.—As the experiments hitherto performed had, as shown above, given very encouraging results, we were induced to make an extensive series of experiments at Brödtorp in the year 1887, to which Baron Hisinger consented and gave, as before, his friendly assistance.

Figure 2 shows the field in which the experiments were performed.

A, sown with wheat, 1·5 hectare under the action of the machine, S_1, reaped area, 2,234·5 m².
A′, „ „ 0·5 „ reaped area 1,931·2 m², S_2
Ac, „ „ 0·5 „ serving as control field, reaped area, 2,895·9 m².
B, „ rye 1·5 „ under the action of the machine, S_1, reaped area, 15,000 m².
B′, „ „ 0·5 „ under the action of the machine, S_2, reaped area, 15,000 m².
Bc, „ „ 0·5 „ serving as control field, reaped area 5,000 m².

The field, D, about 4,000 m², was divided in squares of 49 m², some of 35 m². The following plants were sown:—

Barley	14	squares, alternating field of exps. and of control.
Oat	14	„ „ „ „ „
Potatoes	14	„ „ „ „ „
Red beets	2	squares, the one field of exp. the other of control.
Beans	2	„ „ „ „ „
Raspberries	2	„ „ „ „ „
Carrots	2	„ „ „ „ „
Swede-turnip	2	„ „ „ „ „
Tobacco	2	„ „ „ „ „
Lime	2	„ „ „ „ „

					On 1 ha.
S_1 on 3 ha	rye	29	× 2·15 =	62·4	20·8
	wheat	38	× 2·15 =	81·7	27·2
P_2 on 1 ha	rye	43·5	× 1·77 =	77·0	77·0
	wheat	57	× 1·77 =	100·9	100·9
M_1 on 0·2 ha	red beets, &c.	56	× 1·09 =	61·0	305·2
M_2 „	other plants	56	× 1·0 =	56	280·0

To measure the whole quantity of E was very difficult, because the potential varied between wide limits during a day, and could go down to nearly zero if the humidity in the air was great.

The speed of the machine can be varied much and thereby the quantity of electricity. In the present experiments the speed of S_1 and S_2 was 3·6 revolutions, and of M_1 and M_2 6 revolutions in a second. The necessary work for all the four machines cannot be estimated to more than 0·1 of a man's work.

The Results.

When the experiments began on June 8th the rye ears were developed, and an increase of that crop was not to be expected. The wheat was damaged by root worms, and it was impossible to take in consideration the whole field. We took the expedient to measure the undamaged areas, and received the areas mentioned in the table as reaped areas. If, now, the fertility of the field had been equal everywhere, it would have been easy to calculate the results, but that was not the case, and it could be seen that a supposition of equal fertility would give a totally erroneous result. The only way to attain a probable result was, of course, to get an approximately true estimation of the fertility of the fields. By the assistance of the skilful manager of the estate, Mr. Borg, and guided by the reaped crops, we arrived at the following relative numbers for the field:—

A	A′	Ae	B	B′	Be
1	1·25	1·75	1	1·1	1·35

In this operation we have taken care to state rather less than more, hence the above numbers represent a minimum. The reaped crop was very well sifted into two qualities, the 1 ma qu. and the 2 a qu.

(To be continued.)

Table I.

	Experimental field. Reap area in m².	Weight of the crop in kg. 1 ma. qu.	2 a. qu.	Sum.	Control field. Reap area in m².	Weight of the crop in kg. 1 ma. qu.	2 a. qu.	Sum.
1 rye	15,000	424·0	2,295·5	2,719·5	5,000	134·1	840·6	974·7
2 „	5,000	147·9	771·6	919·5				
1 wheat	2,234·5	177·45	470·48	647·9	2,895·9	295·6	675·1	970·7
2 „	1,931·2	263·0	180·0	645·0				

Calculating the crop in kg. for m², we find:—

	Experimental field. 1 ma. qu.	2 a. qu.	Sum.	Control field. 1 ma. qu.	2 a. qu.	Sum.
1 rye	0·0282	0·1216	0·1498	0·0268	0·1681	0·1949
2 „	0·0296	0·1543	0·1839			
1 wheat	0·0794	0·2106	0·2900	0·1021	0·2231	0·3255
2 „	0·1372	0·1967	0·3340			

	Direct results. 1 ma. qu.	2 a. qu.	Sum.	Derived results.
Rye	+ 5·2 per cent.	− 21·7 per cent.	− 23·14 per cent.	+ 3·7 per cent.
	+ 10·4 „	− 8·2 „	− 5·64 „	+ 15·7 „
Wheat	− 22·23 „	− 5·6 „	− 10·82 „	+ 51·4 „
	+ 34·38 „	− 12·25 „	+ 2·71 „	+ 39·5 „

The electrical machines used in these experiments were of the self-charging type (Holtz), 2 greater S_1 and S_2, 2 smaller, M_1 and M_2. Compared with each other they gave the following result:—If the electricity given in a second of $M_2 = 1$ with the ordinary employed speed of rotation, we shall have $M_2 = 1$, $M_1 = 1·09$, $S_1 = 2·15$, $S_2 = 1·77$. All machines were united by wheels and straps with a common axis, put in rotation by hand, viz., two men, alternating every 6 hours. Though all possible precaution was taken, the machines were not occasionally ineffective, sometimes owing to contact between the plants and the wires, sometimes by other circumstances, but by notes taken during the experiments, the time for real effect can be calculated as follows:—

		In activity. Days.	Effective work.
S_1 on 3 ha.	rye	58	29
	wheat	76	38
S_2 on 1 ha.	rye	58	43·5
	wheat	76	57
M_1 on 0·2 ha	red beets, potatoes, oats	84	56
M_2 „	other plants and partly corn	84	56

Taking the number of days multiplied with the relative strength of the machines, we shall have relative numbers for the quantity of electricity given:—

INSTITUTION OF ELECTRICAL ENGINEERS.

"Rotatory Converters." By Prof. Silvanus P. Thompson, D.Sc., F.R.S., Vice-President. (Paper read November 10th, 1898.)

(*Continued from page 760.*)

In every actual case there are, of course, losses (*a*) by friction, hysteresis, and eddy currents, (*b*) by heating of the resistances in the armatures. The former have to be paid for by an increase in the motor current. Suppose them in the present case to amount to 4 per cent. for each armature, then 108 amperes instead of 100 must flow in from

the supply circuit. The heat losses manifest themselves electrically by a fall of potential at the terminals of the generator, and by a fall of speed in the motor if the primary voltage is not raised. Let the primary voltage be supposed to be raised the requisite small percentage to keep up the speed and to maintain the secondary voltage at 70·7 on the generator side; the output of the generator will then be 10 kilowatts, the input at the motor 10 kilowatts *plus* the number of watts required to make up all the various items of lost power. Though the armatures are of equal resistance, and are respectively receiving and giving out (approximately) equal amounts of electric energy, the armature of the alternate current side (whether used as generator or motor) will heat more than that of the continuous current side; for it carries $\sqrt{2}$ times as large a current, and the ohmic heat will be proportional to the square of this, or twice that produced in the continuous current armature by the 100 amperes of working current. In each armature the heat will be developed equally in all the separate coils around the ring. As the armatures are alike, and as the similarly placed windings in each are passing through identical magnetic fields, there is no reason why one winding should not answer for both purposes. Fig. 4 shows the

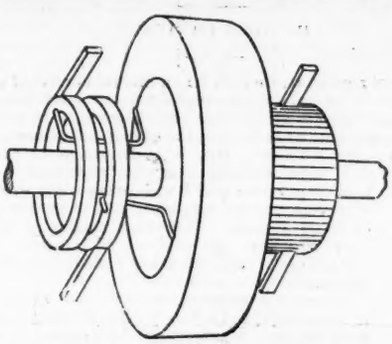


Fig. 4.

case in which this change has been made. One armature only is used; it is connected at one end to the commutator, at the other to the two slip rings, and the machine now becomes a simple *rotatory converter*. The total hysteresis and eddy-current losses will obviously be now one-half of their former amount. The total heating due to resistance will be also reduced, because now the single winding has to carry only the difference, of the two currents—a point presently to be considered—and the ohmic losses will be less. The waste of power, in fact, is approximately halved. How far this economy of losses can be carried depends on the number of phases of the alternating current. But there is another consideration involved—the question of armature reactions and sparkless collection of current. In the combined pair of machines called a *motor-dynamo*, the brushes on the continuous current side must be set, exactly as in any continuous current machine, with a lead, negative or positive, according as whether it is operating as motor or dynamo. In the *rotatory converter* no lead in either sense need be given to the brushes, for the armature reactions of the motor part being, in general, opposed by those in the dynamo part, they cancel one another to a large extent. This property, which is common to all those motor-generators in which there is used, whether with one winding or two, a common core in a common field, was pointed out by the author* in 1888, when giving the theory of continuous current transformers.

* *Philosophical Magazine*, August, 1888.

The relations between speed and field are peculiar. In the case of those grouped machines, or motor-dynamos (fig. 3), in which each armature revolves in its own field, the conditions differ from those of the converter (fig. 4), where there is only one field. If, in either case, the continuous current side is the primary (*i.e.*, motor) side, the speed of revolution will depend on the field magnet, the weakening of which will increase the speed. The frequency of the secondary or alternating current will in that case also vary. But the ratio of the primary and secondary voltages will be independent of speed if the fields are alike, or if only one common field is used. The secondary voltage cannot be varied, while the primary voltage is kept constant, unless separate fields and separate windings are employed, as in fig. 3.

If, on the other hand, the alternating current side is used as primary, then the machine, whether motor-dynamo or converter, runs as a synchronous motor with a fixed speed. In that case the voltage ratio remains also nearly a constant, even though the excitation of the field is increased or diminished, owing to the peculiar phase relations which take place, as is known, in the currents of synchronous motors when under-excited or over-excited. This question, and the expediency of exciting in series or in shunt from the continuous current side, or of running without excitation, has been discussed by Mr. E. J. Berg in the *American Electrician* of February, 1897.

Returning to the question how the current in the armature of the converter gets through the windings, it will be found that a simple means of answering it is afforded by the principle of the superposition of instantaneous values of currents. Still taking as a concrete case the 10-kilowatt converter of fig. 3, we may calculate out the instantaneous values of the currents in its windings at different epochs in its period of rotation. If we do this for the motor currents, and for the generator currents separately, and then superpose them, we shall obtain a number of instantaneous values for the combined armature as converter. This has been done in the series of drawings in fig. 5. If the continuous current acts as motor taking 100 amperes, there will be 50 amperes flowing in each half of the winding at every instant—*qua motor*—in a direction opposing the electromotive force in the winding. This is shown in the first diagram in the upper row of fig. 5. As single-phase generator the armature is working, as already described, with a virtual voltage of 70·7 volts, and an output (supposing the power factor = 1) of 141·4 virtual amperes. The maximum current will be $141{\cdot}4 \times \sqrt{2} = 200$ amperes, and this will be attained at the instant when the two conductors which lead down from the winding to the slip rings are turned to the position of 90° to the axis joining the middles of the pole faces. The eight diagrams which follow in the top row of fig. 5 exhibit the successive values of the currents flowing in the armature —*qua generator*—in positions differing successively by 15°. By supposing these eight diagrams successively superposed upon the motor diagram which precedes them, we obtain the eight diagrams

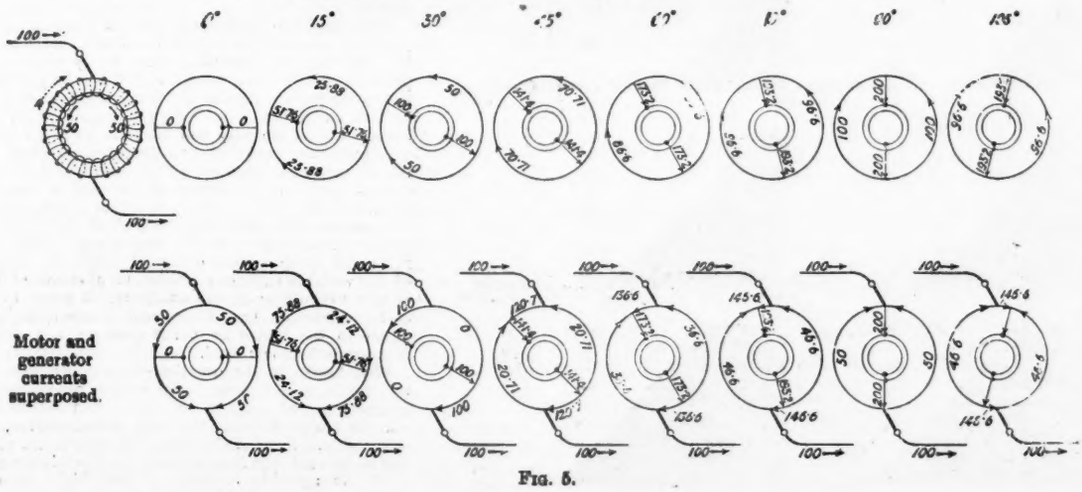


Fig. 5.

of the lower row, which exhibit the currents actually flowing in the different parts at the particular times when the armature has the position shown.

Examination of these diagrams shows several interesting points. At the instant when the alternating current is reversing, and has zero value (at position 0°), the armature is operating simply as a motor with 50 amperes in each half of the winding, and is being accelerated. At the 90° position, when the alternating current is at its maximum (200 amperes), the armature is operating wholly as a generator, and with an equal current of 50 amperes in each half of the winding, and the acceleration is negative. The armature is thus adding 100 amperes to the 100 amperes coming in from the primary mains. Nothing has here been allowed for the extra power needed to make up for the frictional and other losses. Suppose that an additional 4 amperes were needed for this, making 104 amperes as the motor current; in position 0° the two downward currents would be 52 each instead of 50, increasing the positive acceleration; in position 90°

the upward currents would be 48 instead of 50, decreasing the negative acceleration. The outward current at that instant would still be 200, being made up of 104 incoming plus 96 generated in the windings.

On further examining these diagrams, it will be seen that the currents in the armature windings consist of a set of four currents, each in position 0° being 50 amperes. But as the armature turns these change. They increase in the two arcs that are shortening as the points where the slip ring connectors approach toward the positions occupied by the commutating brushes. But in the two other arcs that are lengthening, the currents first decrease to zero, then increase again to 50. Further, the individual coils in different parts of the ring winding have very different currents to carry. A coil that is midway along the winding between the two connectors has to carry never more than 50 amperes. Four times in each revolution it carries 50, and four times it carries 0 amperes, with values intermediate in intermediate positions. (This will obviously set up four armature reactions in each period.) But a coil that is situated next to either of the two connectors has to carry a current which, when it is close to the brush position, rises to a maximum of 150 amperes, and changes abruptly to 50 in passing the brush, rising thus gradually twice to 150, or else rising twice abruptly from 50 to 150, and being zero twice, in one revolution. The necessary consequence of this is that the coils which are close to the slip ring connectors are much more heated than those which lie midway along the periphery between the connectors. The distribution of the heating is here quite different* from that which would obtain in either armature of the motor-dynamo machine (fig. 3). This unequally distributed heating effect is in total somewhat greater than that in the same armature if used purely as a continuous current motor or generator, but is less than the total

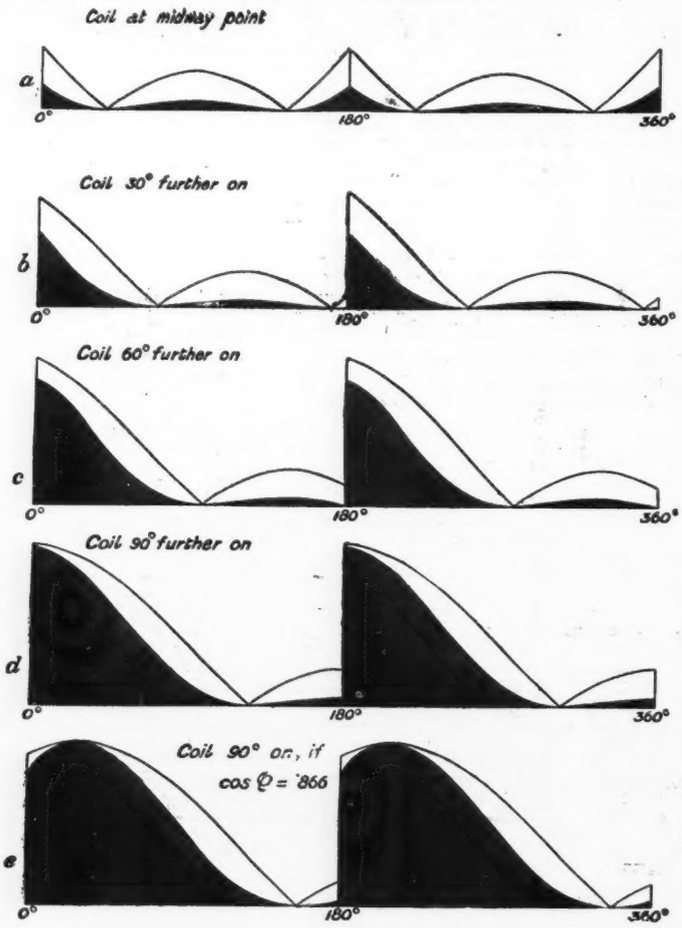


Fig. 6.

heating effect (for equal power) if used purely as single-phase generator or motor; the ratios of the heating being as 1 : 1·366 : 2 in the three cases. Or, if we consider the output of an armature to be limited by equal heating effects, the several outputs which would give equal total heating in the same armature would be:—As continuous current generator or motor only, 100 kilowatts; as single-phase generator or motor only, 50; as single-phase converter, 85 kilowatts. Fig. 6 exhibits this unequal heating effect in the case of a single-phase converter. The first line represents graphically by the outline diagram the varying current (irrespective of direction) which a coil midway between the connectors will carry in one revolution; and the outline curve of the darkened area within it is drawn with ordinates squared so as to be proportional to the heating effect at different instants. The total area blackened represents the total heating effect in that coil. The second line represents similarly the current and heating for a coil 30° further towards the connector. The third line represents current and heating for a coil 60° further. Whilst the fourth line represents similarly the current and heating in a coil that is next to the connector. The relative heatings in these four coils are about in the proportions 10, 21, 50, 86. The curves in the fifth line depict the case of one of the coils next to a connector when there is, in consequence of self-induction in the circuit, a lag of 30° in the phase of the current. The result of such phase-difference is an increase of heating for the whole armature, but an extra increase for those coils which are near the connectors.

(To be continued.)

* *Vide* Steinmetz, *loc. cit.*, p. 154.

STEAM ENGINE GOVERNORS.*

By JOHN DAVIDSON.

Governors, or regulators, are used for an infinite number of purposes. They are used to control the time that a machine must take to perform a certain duty for which it has been designed, or to regulate the output of a machine, so as to keep the output within certain limits, a constant quantity per unit of time, or to determine the path which a particular link in same machine must take periodically; but the kind of governor that I wish to say a few words about this evening is the one that is used to control the speed of steam engines. Somewhat similar governors are used also for gas engines, oil engines, turbines, water-wheels, &c., but these I shall not consider in this paper.

The work a steam engine has to do per unit of time is not always, and not very often for long together the same amount, consequently the quantity, or the pressure of steam used per revolution, has to be varied accordingly, if the revolutions per unit of time have to remain the same during these changes, which vary greatly in different engines, depending upon the kind of machinery the engine has to drive, for instance:—The work of a pumping engine delivering water always to the same height, and with a constant supply for suction, would be a very equal amount per revolution, whereas an engine driving a dynamo for power or traction purposes may have no load to deal with one minute, and full load the next.

The function of the governor is to automatically keep the speed of the engine, or the number of revolutions per unit of time, within certain limits, during these variations in the amount of power to be exerted by the engine.

There are two methods in use for controlling the supply of steam to the engine to suit the load it has to do, viz., first, by throttling—that is, by varying the pressure of the steam used, while the cut-off, release, and compression remain the same; and second, by variable expansion—that is, by altering the position of cut-off, and when only one valve is used for steam admission and exhaust, the compression also, the initial pressure remaining the same. With the throttle governor, if a portion of the load be taken off an engine, the initial pressure is reduced, and prevents the engine racing, and when more load is added the pressure is increased, so the engine only works with full boiler pressure when doing full load. In the case of the variable expansion engine, an increase of load is met by cutting off the admission of steam to the cylinder later in the stroke, and so admitting more steam to the engine at boiler pressure, and with a decrease in load *vice versâ*.

With regard to the question of economy with the two kinds of governing, under certain conditions one is practically as good as the other, and where this, viz., economy is then the only consideration, the cost and simplicity of the gear often determines which has to be used, and in most cases the throttle governor is the cheapest to construct. The high range of expansion at very light loads with variable expansion governing makes it rather unsuitable for economy's sake if the engine runs for long periods at very light loads, and points to a combination with the throttle governor, so that a later cut-off may be used for the smaller loads, which, in the case of compound engines, would tend to equalise the variation of temperature in the two cylinders, and if the governor be made to control the admission to both cylinders simultaneously, it would benefit this still more than if the high pressure valve only be under the control of the governor. In the case of shaft governors working the main valve, the port openings at the early cut-offs are greatly restricted, and throttling takes place, which, to some extent, combines the two methods of governing.

From reliable tests, however, it is found that even at light loads

* Paper read before the Salford Science Students' Association at the Royal Technical Institute, Salford.

the gain by throttling is not so very great, and in well-designed installations it is not general to run engines half their time at one-quarter or less than full load.

Mr. Charles Porter, in his paper read before the American Society of Mechanical Engineers at the New York meeting, 1895, considered this question in the following light:—

Let the losses from internal condensation and waste room be assumed at 20 per cent. in the variable expansion engine, and also in a fixed cut-off engine, both cutting off at one-third of the stroke in each cylinder and working dry steam. In the former engine these losses continue the same however early the cut-off may take place. When this is at ·1 of the stroke, a not unusual point, they add about 70 per cent. to the steam usefully employed. If the latter engine be throttled to corresponding reduction in power, then, from superheating of the steam and the increased efficiency of the steam jacket, and the complete filling of the waste room by compression, these losses, instead of increasing in relative amount, must nearly, if not quite, disappear. He further on says:—The fixed cut-off is also better adapted to the system of compounding. The volume of steam exhausted from the high pressure cylinder is a constant volume. It is clearly necessary to the proper manipulation of the steam that the volume or capacity of the receiving cylinder up to the point of cut-off shall be equal to this and be constant.

The fixed cut-off enables this requirement to be complied with. A variable cut-off on the receiving cylinders renders such a compliance impossible. The volume in this cylinder up to the moving point of cut-off, may be two or three times too large, or it may be an indefinite number of times too small. It is clear that if the variable cut-off had not been already in common use, nothing so unsuitable would have ever been designed for this purpose. This is truly an exaggerated argument in favour of the throttle governor for considering the loses due to variable expansion, if the compression increases as the load decreases, and the clearance spaces are completely filled with steam at almost initial pressure by compression; and, again, if at the light loads a little throttling does take place, this will considerably reduce the enormous difference in the economy at light loads when imagined as above. Also in many compound engines governed by variable expansion the high pressure valve only is under control of the governor, and the low pressure has a fixed cut-off; so if it is necessary that the volume of the low pressure up to the point of cut-off should be equal to the volume of the high pressure cylinder exhausting into it, under these conditions it can be so. Still, if the low pressure valve also be under control of the governor, a far more equal distribution of power and temperatures in the two cylinders is effected.

In the case of an engine working with a variable load, say, from one-third to full continuously, or a mean of about two-thirds, the best governor to use for economy would be the variable expansion, for if the throttle be used the cut-off for all loads would have to be late enough to give the full load at boiler pressure, or really at something less than the working pressure, to allow for variations in the steam pressure; and this points to losses due to not using steam expansively, or, at any rate, to the best advantage at the intermediate loads.

There is one thing worth noting here, viz., that with the throttle governor the indicator card retains the same characteristics at all loads, whereas with the expansive governor, where only one valve is used for the steam and exhaust, the position of release and compression are also altered, the compression increasing as the load decreases.

This has its advantages. It prevents loss at light loads due to the clearance spaces by filling them with steam compressed almost to boiler pressure, and thus lessening initial condensation; but this loss is again felt at the heavier loads as the compression is reduced.

The effect of the compression can be overcome by the use of two valves, the governor controlling the steam admission only, the release and compression being determined by the other valve, and remaining the same for all loads, and being worked by an independent eccentric. Then the clearance spaces may be reduced as much as is practically possible, without any fear of excessive compression at any load, which will again benefit economy.

The excessive compression gives the governor more control of the engine at light loads, but it is detrimental to a good turning effort of the crank, and it increases the internal friction of the engine.

Mr. Frank Garret, at a meeting of the Institution of Mechanical Engineers, 1895, gave the results of some very interesting experiments on simple and compound engines, comparing the steam consumption and the mechanical efficiency when governed by throttling and by variable expansion, worked by a shaft governor. As these results show very clearly the different effects of the two kinds of governing, although with rather low steam pressures. I repeat the table of results here:—

Single Cylinder Engine, 9 Inches Diameter, 12 Inches Stroke.

Boiler pressure 85 lbs. per square inch.

Governing by throttle or by variable cut-off.	Throttle.	Cut-off.	Throttle.	Cut-off.	Throttle.	Cut-off.
Initial pressure in cylinder	75	83	69	82	57	82
Cut-off, percentage of stroke	50	37	50	31	50	17
Revolutions per minute	147·2	148·1	150	148 6	152 9	149·4
Indicated horse-power	24·5	24 4	19 5	18·73	14·83	14 58
Brake horse-power	20·05	20·1	15·2	15·06	10·16	9 94
Mechanical efficiency	82	82	78	80·4	69	68
Steam consumed per indicated H.P. per hour	31·53	28·41	31·75	27·83	32 21	28·51
Steam consumed per brake H P. per hour	38·58	34 4	40 73	34 62	44 07	40 1
Saving in steam	...	10·8	...	15·	...	9 0

Double Cylinder Compound Non-Condensing Engine.

Cylinders 7¾ inches and 11½ inches diameter, and 12 inches stroke. Boiler pressure 135 lbs. per square inch.

Governing by throttle or by variable cut-off.	Throttle.	Cut-off.	Throttle.	Cut-off.	Throttle.	Cut-off.	Throttle.	Cut-off.
Initial pressure in high pressure cylinder	128	131	113	131	87	131	63	151
Cut-off, percentage of stroke	60	54	60	41	60	34	60	20
Revolutions per minute	151·2	153·6	150 8	152	153·2	154 3	154 6	155 1
Indicated horse-power	49·37	51·4	41·29	40·06	31·02	30·09	22·35	20 2
Brake horse-power	39·15	40 03	30	30·5	21·4	21 68	12 37	12·47
Mechanical efficiency	79·3	77 9	72·6	76·1	69	72	55 3	61 7
Saving in steam per brake horse-power per hour	...	2·8	...	8 2	...	7·7	...	16·4
Steam consumed per indicated horse-power per hour	22·88	21 88	22·05	21·19	24·39	23 46	28·29	26 4
Steam consumed per brake horse-power per hour	28·85	28·05	30·37	27·88	35·30	32·57	51·12	42·76

You will see by the tables that, with the single cylinder engine, the mechanical efficiency, when governed by variable expansion, is almost the same as when governed by the throttle at the 10 and 20 B.H.P. loads, and a little better than the throttle at 15 B.H.P., or at the most economical load, whereas the saving in steam by the variable expansion over the throttle is 15 per cent. at 15 B.H.P., and 10 8 and 9 per cent. at the 20 and 10 B.H P. loads respectively.

With the tests of the compound engine the saving in steam consumption per I.H P. of the variable expansion over the throttle is not so great as in the single cylinder engine, but as the mechanical efficiency is much higher than the throttle, the saving in steam per B.H.P. is very considerable.

These tests show the variable expansion engine to be the highest in mechanical efficiency at all the loads shown, and it would appear to be the best for all purposes; but there are some instances in which the throttle will give as good results if properly designed. For example:—an engine running always at full load or a very light load, or an engine always at one steady load, but for an engine with a constantly varying load, and especially with sudden variations of load, the automatic expansion governor is preferable.

Mr. Alfred Morcam, in his paper read before the Institution of Mechanical Engineers, 1897, also gave the results of two tests of a 250-H.P. quick revolution self-lubricating condensing engine when governed by expanding and by throttling (see Table).

These results, you will see, show the throttle-governed engine to be the most economical at all loads when the E.H.P. is considered, and even at full load when the two engines should be running under practically the same conditions. Anyway, they show that if the throttle governor is adjusted to run under the best possible conditions as regards economy, there is very little difference in the two types of governing at and near the full load.

If the throttle governed engine in the test had the cut-off arranged so as just to give the full load at the full boiler pressure, it was under rather more favourable conditions than it would be in ordinary practice, as the cut-off would have to be fixed a little later to allow for variations in steam pressure or slight overload.

Again, considered as a governor purely or as a means whereby to automatically control the speed of an engine, neglecting other effects, there is no doubt that the most efficient governor is the variable expansion.

Governed by expansion governor or by throttling.	Expanding. Expansion governor in action.				Throttling. Expansion governor out of action.			
Load	Full	⅝	½	¼	Full	⅝	½	¼
Mean effective pressure per sq. inch reduced to L.P. cylinder ...	41·0	27·0	16·4	12·4	40 1	25·9	15 7	10 9
Mean revolutions per minute	370	373	380	380	370	370	380	382
Mean indicated horse-power	240 9	161·0	99 0	75·3	235·4	152 2	95 0	66 2
Mean electric horse-power	213 0	132 8	77 8	53	213·0	132 2	77 8	53 0
Combined efficiency $\frac{\text{E.H P.}}{\text{I.H.P.}}$	83 3	82·4	78·5	70 3	90 4	86 8	81 9	80 0
Water per hour, total	4,579	3 041	2,209	1,818	4,473	2,871	1,992	1,505
„ „ per E.H P.	21 5	22 9	28·5	34·3	21 0	21 7	25 6	28 4

(To be continued)

THE BRADFORD TRAMWAY ACCIDENT.

Major P. Cardew's report on the electric tramway accident which occurred in Bradford on September 19th has been issued. The following points are extracted from it. After setting forth the circumstances of the accident, and reviewing the evidence, the report states that a very important question was raised at the coroner's inquest on the victims of this accident as to the sufficiency of the brake power provided on this tramway, and certain tests were carried out by an expert appointed by the coroner. In these tests two cars were coupled together, and were allowed to run freely for a distance of 72 yards down a gradient of 1 in 14 24. They were then stopped by the application of brake power on one car only in distances, from the point of application, of 91 yards for the hand brake kept on, 70 yards for the hand brake applied intermittently, and 68 yards for the electric brake. Afterwards similar experiments were made with one car alone, when the hand brake brought the car to a standstill in 36 yards 1 foot, and the electric and hand brake in combination in a distance of 25 yards 1 foot, and at a second test, of 21 yards 1 foot. The car was afterwards run down the gradient under control, the electric brake being used on the second point of adjustment, which is what the drivers have been instructed to use, and was stopped in 9 yards. These tests appear to me to indicate very efficient brake power. Under the conditions, the car must have acquired a velocity of about 20 miles an hour, and to stop it on the incline in 21 yards 1 foot requires a force of nearly one-quarter of the whole weight, applied in the opposite direction to the motion. This I consider about the maximum retarding force that can be expected from any braking arrangement which depends upon friction between the wheels and the rails.

As upon my reaching Bradford on the 12th inst. I found that a slipper brake had been fitted upon one of the cars, and was available for test, I proceeded to the Horton terminus to examine the arrangement, and carried out similar tests to the above with this brake and the other brakes, in the presence of the Tramways Committee of the Corporation. The results obtained were as follows:—

Car allowed to run free on grade of 1 in 14·24 for a distance of 72 yards, and then stopped—

By the slipper-brake alone in 179½ yards
„ hand „ „ 64½ „
„ electric „ „ 37 „

Car allowed to travel down the grade with electric brake on at second point stopped in about half its length, or, say, 5 yards.

From these tests it appears that the slipper brake alone, as now fitted, is the least effective of all as an emergency brake, that is, I consider, to some extent due to the flat pitch of the screw by which the brake is applied, but, considering the small fraction of the whole weight of the car that can be possibly brought to bear upon this brake, I doubt greatly whether it can be made as effective an emergency brake as the other brakes which act upon all the wheels, and which, therefore, bring into play as a retarding force a friction due to the whole weight of the car. It has, however, an advantage in that it applies a surface of wood to the steel rail, the coefficient of friction between wood and iron or steel being generally greater than that between iron and iron. The fact is that if a car be allowed to acquire such a speed as 20 miles an hour on a steep gradient, no brake acting by friction on the running rails will stop it in a distance that could be considered safe. There appears to be an impression that a slipper brake is quite without influence upon the wheel brakes. This is not the case; whatever proportion of the weight of the car is utilised for the slipper brake must be lost for the wheel brake, and it will be found that the wheels skid more easily on the application of the hand brake if the slipper brake be pressed down. Moreover, to the extent to which the slipper brake relieves the weight on the wheels it tends to increase the risk of the wheels leaving the rails at curves and facing points.

The real advantages of the slipper brake appear to me, as before remarked, to be found in the use of a block of wood pressing on the rails, whereby a greater coefficient of friction is secured, and the destructive action inseparable from the dissipation of energy by means of friction is to a great extent concentrated upon a cheap and easily replacable fitting. The addition of this brake to those already provided also adds one more to the method of retardation available. There are, however, three methods available without it, viz., the hand brake, the electric brake, and the reversal of the motors.

With regard to the question how far the curve from Great Horton Road to All Saints' Road contributed to the disaster, I would remark that it appears to me that it undoubtedly determined the position of the accident, since it was a physical impossibility for the car to go round this curve at such a speed. It is also quite possible that, had the curve not existed, the driver might have recovered control of his car before anything serious happened. On the other hand, a runaway car is an imminent danger even on a straight road, and, had the accident been caused by collision with another vehicle, the consequences might easily have been still more disastrous. The Corporation have arranged a fixed stop just above this curve on the down journey. This is, perhaps, desirable, as tending to ensure that the curve is taken at a slow speed, but it is, of course, no security if the car is allowed to get out of control.

In conclusion, I am of opinion that the accident was due to the following causes:—

1. That the cars were not run within the limit of speed required by my report to the Board of Trade, viz., not exceeding six miles an hour on the down journey.

2. The unfortunate combination of a driver with very little experience; a conductor with none at all, but with a little knowledge, which is proverbially a dangerous thing; a slippery road; and extra pressure on the traffic due to Barnum's show.

The driver certainly used the brake power provided in an injudicious manner. The conductor put on the hand brake, and thus deprived the driver of the full control of the brake power, and he also caused the trolley to be disconnected, thus depriving the driver of the power of reversing, which might have prevented the accident. I consider the brake power ample, and that by means of the graduation of the electric brake, the speed can be regulated with ease and certainty, provided that a speed of 6 miles an hour be not exceeded. I approve of the addition of a slipper brake, as recommended by the coroner's jury—not, however, as an emergency brake, but as a brake to be continuously in use, since by it also exact regulation of speed can be obtained, and its use will diminish the strain on the motors, and the excessive wear of the wheels.

With reference to another recommendation of the coroner's jury in this case, viz., that two sand boxes be fixed to each platform to enable the driver to sand both rails, I think these should be arranged so that one can be used alone, otherwise difficulties may be caused on the up journeys from occasional loss of electric contact with the rails. It would, perhaps, be more judicious to station men to attend to the sanding of both rails at the dangerous points on the down journey.

I adhere to the opinions expressed in my report of inspection that the speed on the down journey should not at any point exceed six miles an hour, and that trailer cars should not be allowed on this line, and, provided that the requirements of that report are complied with, I recommend that the line should be certified by the Board of Trade as fit for traffic. It must be fully recognised, however, that on this line the greatest caution and strict attention to regulations are essential to safety. The time occupied on the down journey should be at least 35 minutes, and more time should be allowed for this than for the up journey.

I wish to add that, although the accident was in a great measure due to the inexperience and injudicious action of the driver and conductor, in my opinion they both did their duty to the full extent of their skill and ability.

LABOUR REPORT FOR 1897.

The Board of Trade have issued their annual report on the strikes and lockouts of the late year.

This blue book records 864 disputes during the year, many of them, of course, of a trivial nature—the engineers' strike being the most serious. The aggregate of the disputes totalled up to 10 million working days. Taking the year as 300 days this is equal to a year's work of 33,333 men, of which 20,000 represents the engineers alone, not to mention the further time lost during the following year into which the strike extended. Yet already on the current year, nearly 15 million work-days have been lost during the first nine months, mainly because of the Welsh coal strike, which has been chiefly apparent in London because of the Smoke Act prosecutions. The present report omits disputes involving less than 10 persons or less than one day's stoppage, unless the aggregate time lost amounts to 100 man days.

In 1897 the total number of persons involved in strikes was 230,627, which is less than for the years 1894 and 1895, and only

one-third of the number for 1893. The following table is interesting, as it gives both the persons affected and the time involved for a period of five years. It is seen that while the time element was large, the personal factor was small in 1897, indicating long duration.

Year.	Persons affected.	Aggregate working days.
1893	636,386	31,205,062
1894	324 245	9,322,096
1895	263,758	5,542,652
1896	198,687	3,748,525
1897	230,267	10,345,523

The proportion of the working population involved is about 2 per cent. in 1897, and about 3 per cent. in the whole series of years, and except for the year 1897, mining furnished the largest proportion for a group of trades, or 22 per cent. in the group of years, and 5·9 per cent. in 1897, in which single year the percentage furnished by the engineering trades was 8·8 per cent. Generally the proportion of the working population involved in strikes is small.

Some idea may be formed of the magnitude of the engineering strike by comparison with other strikes. The 1893 coal strikes involved 300,000 men in England and 90,000 in Wales. In 1894 there were 70,000 Scotch miners affected; in 1895 46,000 bootmakers, while only 47,500 were affected by the strike of 1897. As a rule the 1897 disputes were settled in favour of the employer in the ratio of 44½ per cent. to 21·6 per cent., though this was chiefly due to the settlement of the engineers' strike. This strike was not a strike for a rational end. It was a strike at a period of high wages, and the object sought was interference in shop management.

This is the more remarkable in face of the fact that employment was not scarce that year. Clearly the average should have been in favour of the employed, and this adds strength to the argument that the demand of the strikers was unreasonable. The final agreement is printed here in full, as are also various other strike documents. To read through the detailed list of strikes one cannot but notice the extreme frequency of various forms of intimidation, the discharging of men at the bidding of the unionists, the resignation of non-union men, too often we fear under brickbat or similar *moral suasion*, and generally, to quote Burns—not our John of that ilk—man's inhumanity to man where the sufferer happens to be a poor struggling labourer.

ENTRANCE EXAMINATION TO THE INSTITUTION OF CIVIL ENGINEERS.

We have not heard much of the results of the new system of entry to the Institution of Civil Engineers. It was somewhere stated at the time the new examination tests were propounded that they were not to take the place of the existing methods, but to be supplementary thereto. From correspondence in the *Engineer*, this would appear not to be the case. An associate member writes to give two sample questions from the paper. He states that they were given him by a friend, who is the assistant resident engineer in one of the largest new harbour works in progress in this country, of some years good experience, and he himself, though resident engineer on a new railway, in receipt of a fair salary, admits he could not solve the questions without reference books. He doubts the ability of other engineers to solve without cramming. If the two questions are a fair sample of the whole, we think he is undoubtedly correct, and we think it would be desirable that the Institute should make known either that these examinations are absolutely the only road or that experience is also a way in. In certain bridge work problems very high mathematics are necessary. Not one engineer in a hundred is capable of solving the problems. A few country parsons, past wranglers, would do the work better than most engineers. Yet to calculate the stresses on an ordinary bridge truss requires little else than elementary mathematics.

One of the principal points to observe, and requiring skilful practical design in a pin bridge, is the disposition of the lower chord bars, posts and diagonals, so as to reduce the binding stresses on the pins to a minimum, and admits of minimum pins and small connections generally. In many other questions mathematics of a high order are uncalled for. Certain electrical problems call for such, but the demand for engineers who can do this work is not large. The few who have the ability, no doubt may do well out of their knowledge, but if all engineers were high-class mathematicians there would be far less scope for the Hopkinsons, and few men have his mathematical ability and equal practical knowledge. As a rule, indeed, mathematical men are not good engineers, for they allow their mathematics to blind them. If there be only this one way into the Institution it must soon become confined either to those who have been able to enter young, or to the few, including professors and teachers, whose whole life is spent on problems of the kind offered for solution. We very much doubt, however, if the experienced engineer will be called upon to pass a mere scholastic examination. If he be called to pass an examination it should be one of practical questions, and, to a very considerable extent, candidates should be allowed to pick their subjects. How many men accustomed to railway work could pass in steam, and *vice versâ*? The worst of examination questions is that they all seem to be set with the object of tripping a man up. They always call for more mathematical knowledge than a man of some years' practice has at his command, and we are of opinion that no examination which is coached up for by candidates can be a true test of ability. The mere scholastic element is far too evident in the questions set at the Institution, and it is bordering on impertinence to make such tests for men of mature age, who have, perhaps, creditably carried out the engineering work of the British Empire, in order that they may be outshone by boys fresh from college. That this would be so is only too well recognised by us all, and we therefore do not think that the entrance by examination is the only door.

Since writing the above we have looked over the rules of the Institution, and, so far as we can see, the old arrangements still stand good. The man of experience can still refer to such experience as ground for claiming admission. The examination test is a sort of additional test, the use of which is not very clear. It seems to be a door of entrance whereby a man of no practical experience or ability to carry out work might be able to secure an entrance. Further correspondence in the *Engineer* discloses the fact that there is a quite general idea that entry is by examination only, though one correspondent points out the actual facts.

It appears to us that there is too great a tendency to regard engineering as a purely mathematical and scientific art. It is not so. There is an enormous amount of science connected with the making of one of the commonest forms of food—bread. Its manufacture is based on the occult principles of fermentation, the checking of this process at an exactly suitable time, the question of temperature is involved, the specific heat of brickwork comes into play, the law of expansion of gases by heat is deeply involved. Yet an absolute ignorance of all these scientific facts is almost always present in those who make the best bread. So it is with engineering. It is an art or many arts based on science. It is essential that some engineers should be fully versed in those arts, but there is no necessity for most engineers to be deeply versed in them. To return to the simile above, practical experience and common sense are more essential than bare science, and the division between science and practice may well be made—one man has one; let him pay for the other man's knowledge. We cannot all be all-wise, but must choose our part; and engineering is a field for sub-division of labour. As a rule it is to be noted that the all round men are pecuniarily the least successful. It is your specialist, whose forces are directed in a narrow channel, and who is often densely incapable of perceiving anything outside his channel who makes the most successful man.

ELECTRICITY FOR LIGHTING AND POWER.

During the discussion of a paper by Mr. Langdon, of the Midland Railway, relative to electric driving, Prof. Kennedy threw doubts on the economy of electric driving, stating that where shafting did not absorb more than 15 or 20 per cent. of the total power it would not pay to put in electricity to drive tools. Probably this may be true where the machines driven are run continuously, but we are inclined to think the percentage above may be very much reduced in most shops where so much time is really filled up in chucking work, &c. Then the economy is not all one of power. There is oil, belting, dust, and obstruction of light by belts, and all that is implied in the foregoing list.

One speaker claimed a good deal for hydraulic power because someone had been wise enough to put an electric motor to drive a pump to work a lift and so on, but Mr. Patchell rather set him right by saying he himself would have tried to make the motor work the lift direct without hydraulic interposition. Mr. Henry Lea also put forward some figures showing that in place of 9 H.P. only 5 H.P. was required at the outside for certain work done by means of motors. At £10 per year per H.P., this saved £50, which was 10 per cent. interest on £500, and the electric motors only cost £150 in this case, so that the saving was very considerable. The moral is that the man of capital can put down what will save him money, while the poor man, who has not got the initial £150, must go on at a loss year by year.

Mr. Head stated that in his experience he had found as much as half the coal saved in some instances, not to name the greater convenience of electrical driving. Mr. Langdon, in his reply, referred to this, and instanced the Bristol Waggon Works as a place saving £1,000 a year by an electrical system. He also pointed out that tools did not work over one-third of the time, and yet when shafting was employed, it was absorbing power all the time, and it was in what was not used, rather than in what was used, that the saving came in.

The secretary explained some diagrams he had prepared, showing power absorption by saws and other machines.

Obviously the large scattered shipyard is the place to prove the economy of electric driving, but we think the small shop is almost better. In the small shop there is a small wasteful boiler, poorly attended shafting, an enormous wages bill on power production, *pro rata*, and innumerable stoppages, not to mention loss of time in getting up steam.

In a city like London, teeming with small workshops, electric driving ought to make good progress. It is simply ridiculous to work small steam boilers of wasteful vertical type and equally wasteful small engines when cheap current is to be had.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

23,388. "Improvements in and relating to electric arc lamps." J. B. Reiner. Dated November 7th.

23,397. "Improvements in enclosed arc lamps" F. M. Lewis and The Mutual Electric Trust Limited. Dated November 7th. (*Complete.*)

23,408. "Improvements in or relating to brush holders for dynamo-electric machines." W. B. Sayers. Dated November 7th.

23,411. "Improvements in the manufacture of electrical cables for submarine telegraph purposes." L. L. Hartvigson. Dated November 7th.

23,420. "Improvements in or connected with incandescence electric lamps." L. J. Steele, Sir J. B. Maple, Bart., M.P., and J. Verity. Dated November 7th.

23,430. "Improvements in electric controller mechanism primarily adapted for railway motors." W. P. Thompson. (T. von Zweigbergk, United States.) Dated November 7th. (*Complete.*)

23,433. "Improvements in and relating to the construction and arrangement of electric arc lamp cut-outs." C. Vernier. Dated November 7th.

23,436. "Improved method of attaching the holders of electric incandescent lamps to their bulbs." E. Bilharz. Dated November 7th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 10th, 1898, being date of application in France.)

23,462. "Improvements in or connected with street electric tramways and railways." G. W. Bell and E. R. Royston. Dated November 8th.

23,481. "Improvements in or relating to electric furnaces for the production of calcium carbide." J. Bastick. Dated November 8th.

23,497. "Improvements in and connected with electrical tramways and in the transmission of electricity to the car or vehicles." W. H. Merriman. Dated November 8th.

23,501. "Improvements in and relating to phonographs and the like." L. F. Douglass. Dated November 8th. (*Complete.*)

23,503. "Improvements in devices for controlling the operation of electric motors." H. H. Lake. (H. See, United States.) Dated November 8th. (*Complete.*)

23,510. "Improvements in insulators for incandescence electric lamps." H. H. Lake. (A. H. Spencer, United States.) Dated November 8th.

23,515. "Improvements in or relating to antiseptic supports for telephone receivers or transmitters." A. J. Boult. (A. Koltz, France.) Dated November 8th.

23,529. "Improvements in a method and system for generating and distributing electric energy." The British Thomson-Houston Company, Limited. (C. M. Green, United States.) Dated November 8th. (*Complete.*)

23,530. "Improvements in a method and system for generating and distributing electric energy." The British Thomson-Houston Co., Limited. (C. M. Green, United States.) Dated November 8th. (*Complete.*)

23,531. "Improvements in a method and system for generating and distributing electric energy." The British Thomson-Houston Co., Limited. (C. M. Green, United States.) Dated November 8th. (*Complete.*)

23,532. "Improvements in electric brakes for electric railway cars and other electrically-operated mechanisms." The British Thomson-Houston Company, Limited. (F. E. Case, United States.) Dated November 8th. (*Complete.*)

23,533. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (C. E. Hartham, United States.) (*Complete.*)

23,534. "Improvements in governors for air compressors driven by electric or other motors." The British Thomson-Houston Company, Limited. (S. H. Libby and W. B. Potter, United States.) Dated November 8th. (*Complete.*)

23,538. "Improvements in or connected with pocket induction apparatus." A. von Terpitz Dated November 8th.

23,541. "Improvements in apparatus for controlling electric motors." H. Leitner. Dated November 8th.

23,545. "Process for obtaining an electrolytic deposit of metallic films on aluminium." O. P. Nauhardt. Dated November 8th. (*Complete.*)

23,556. "Improvements in submarine cable telegraphs." W. L. Wise. (A. C. Crehore and G. O. Squire, United States.) Dated November 8th.

23,593. "Continuous to alternating electric current transformer." H. Chapman. Dated November 9th.

23,597. "Improvements in apparatus for the electro-deposition of metals." J. W. Smith and W. Evans Dated November 9th.

23,659. "Improvements in and relating to the electrical propulsion of tramway cars, railway carriages, and the like." D. Robertson. Dated November 10th.

23,662. "Improvements in electrical switches." J. H. Tucker. Dated November 10th.

23,699. "Improvements in and relating to trolleys and trolley poles used in overhead systems of electric propulsion." R. P. Strachan. Dated November 10th.

23,706. "Improvements in the manufacture of dynamo brushes." J. Leissing and C. L. Hiebl. Dated November 10th. (*Complete.*)

23,716. "Improvements in or relating to secondary or storage batteries." R. Haddan. (G. J. Miller, United States.) Dated November 10th. (*Complete.*)

23,728. "Improvements in or connected with incandescent electric lamps." J. J. Brooke and F. W. Allen. Dated November 11th.

23,750. "Improvements in electro-dynamic relays for use on telephone and telegraph lines." S. G. Brown. Dated November 11th.

23,753. "Improvements in electrical measuring instruments called potentiometers." J. A. Fleming. Dated November 11th.

23,768. "Improvements in rails with cable for electric traction." A. P. Weight. Dated November 11th.

23,820. "Improvements in apparatus for measuring the phase of alternating currents." J. Tuma and M. R. Kaldegg. Dated November 11th. (*Complete.*)

23,821. "Improvements in and relating to coin-freed telephones." A. E. Gillespie and J. Gillespie. Dated November 11th.

23,827. "Improvements in the art of electric dyeing and shrinking and in apparatus therefor." G. D. Burton. Dated November 12th. (*Complete.*)

23,841. "Improvements in brake apparatus for electrically-driven cranes and the like." J. B. Reid. Dated November 12th.

23,853. "Improvements in primary galvanic batteries." S. F. Walker. Dated November 12th.

23,890. "Improvements in electric velocipedes or other vehicles." A. Hansel. Dated November 12th.

23,895. "Electric ignition apparatus for internal combustion engines." A. M. Clark. (La Societe Anonyme des Automobiles Peugeot, France.) Dated November 12th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9*d.* (*in stamps*).

1897.

12,933. "A general switch for groups of electric lamps." O. Imray. Dated May 25th, 1897. Relates to switches for gradually throwing into circuit incandescent or arc lamps, either singly or in groups. In a form shown in the drawings, which is adapted for use with powerful currents, the separate lamps or groups of lamps are connected to posts carrying brushes and all mounted on a cylinder. The brushes bear on a metallic segment carried on a central insulating cylinder, and connected to the leads. On turning the central cylinder by means of a knob, the lamps can be brought into circuit as required. The connection between the knob and the cylinder is made by a spring ratchet, so that the cylinder can only be turned in one direction. The contact brushes may project from the face of a disc and bear on a sector in the face of another disc. Either form of switch is adapted to be attached to an electrolier.

12,936. "Improvements in electric furnaces or electric heating apparatus." A. V. Newton. (A. H. Cowles.) Dated May 25th, 1897. In electric furnaces or other electric heating apparatus in which a gas vapour or the like is passed through a mass of carbon or like material for the purpose of treating either the material or the gas, means are provided for periodically reversing the flow of gas through the apparatus, in order to equalise or regulate the heating effect. In the drawings is shown an application to an electric furnace containing a mass of carbon and a central electrode. Side flues, containing granulated carbon are fitted to the furnace, and communicate by water-jacketed pipes, with a reversing valve, gas supply pipe, and discharge pipe.